The Electrical Industry's Weekly Magazine

May 26, 1958

Electrical World

Price 50 Cents

A McGraw-Hill Publication

EHV

EXTRA HIGH VOLTAGE TRANSMISSION ON 3 CONTINENTS

... PAGE 55

E B POWER GS W
UNIVERSITY MICROFILMS I
313 N 1 ST
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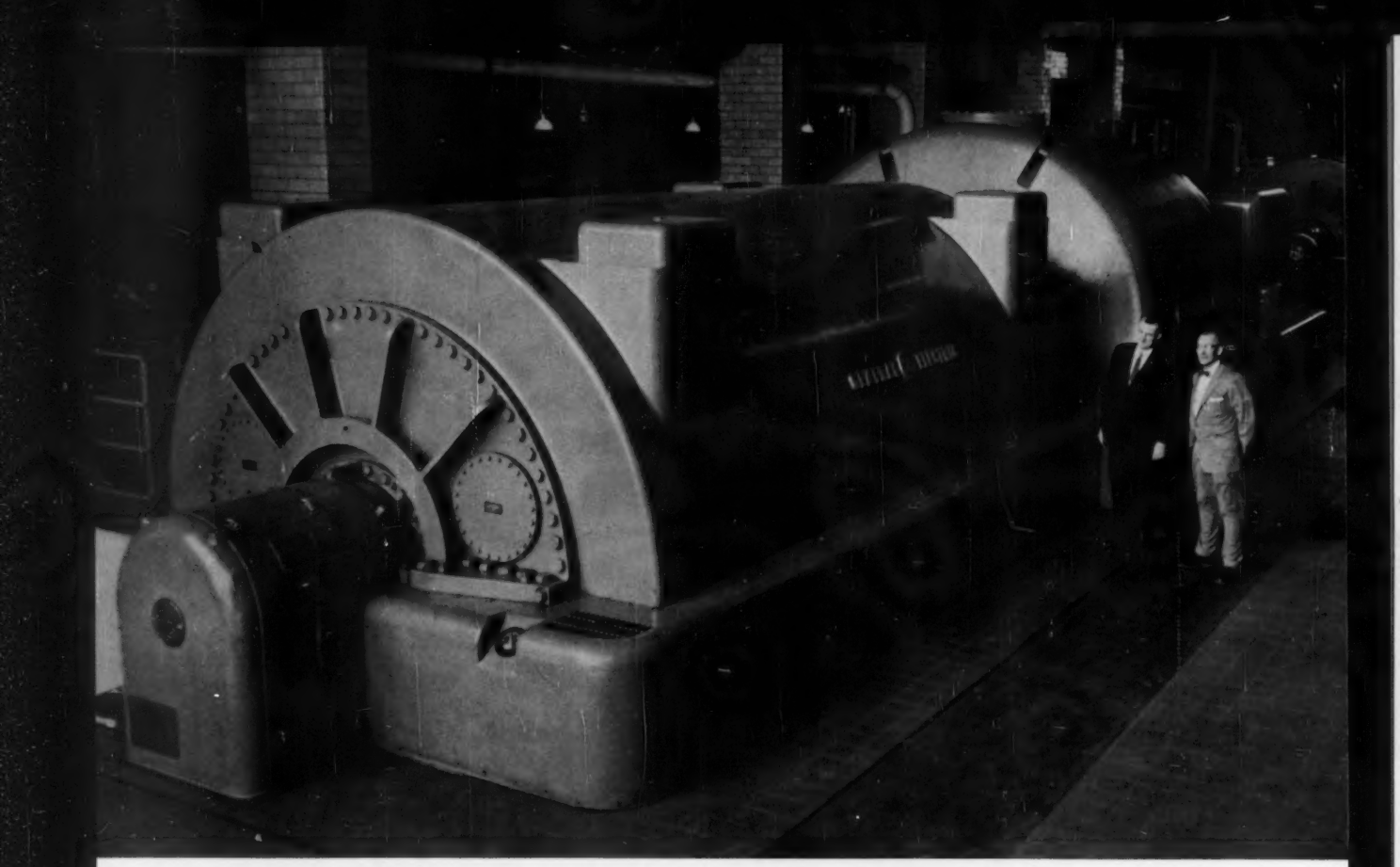
FIRST OF SERIES

Fuel Outlook: Coal Still King . . . page 101



This new 70,000 kw reheat turbine—like all other turbines in this plant—is 100% Texaco-lubricated to keep it free from rust, sludge and foam.

A large Eastern Utility found:

Texaco gives these 3 big benefits for complete turbine protection:

1. Unquestionable dependability. Texaco Regal Oil R&O keeps the utility's turbine system clean; prevents rust, sludge and foam from forming; keeps bearing temperature normal and governor response instantaneous. Texaco dependability is a *fact* for this utility, based on long experience.

2. High efficiency. Texaco Regal Oil R&O assures smooth performance and freedom from unscheduled outages. Texaco Regal Oil R&O gives bearings full protection throughout an extra-long oil service life.

3. Technical service. Texaco offers this important benefit at a time when power demands are almost out-growing turbine production. Past experience in the power plants has proved Texaco Lubrication Engineering Service to be quick and reliable. This service is always available to Texaco customers—whatever the need.

There is a complete line of Texaco Regal Oils R&O to meet the requirements of all leading turbine manufacturers, regardless of turbine type or size. Let a Texaco lubrication expert help you select the Texaco Regal Oil R&O that will keep turbine efficiency high and maintenance costs at a minimum. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States—or write:

The Texas Company, 135 East 42nd Street, New York 17, New York.

LUBRICATION IS A MAJOR FACTOR IN COST CONTROL

(PARTS, INVENTORY, PRODUCTION, DOWNTIME, MAINTENANCE)

Electrical World

Vol. 149, No. 21 May 26, 1958

Published for 84 years for those engaged in the business of generating, transmitting, distributing, or applying electric power

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Here's review and outlook for loan agency on 23rd Anniversary. NRECA contemplates an expanding role.....p 50

MANAGEMENT NEWSLETTER

Fuel Outlook: Coal Still the King

EW's study of utility fuel trends shows coal gaining at least through 1975. First of a three-part series.....p 101

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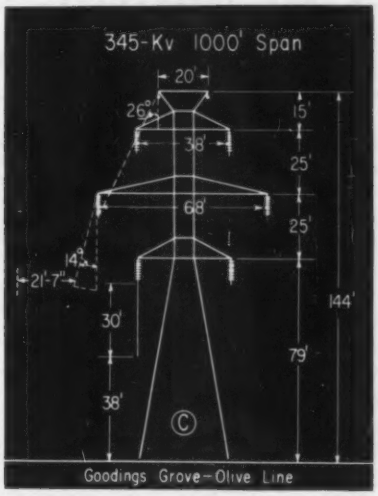

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Germans Overlay Grid with 400 Kv

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McGraw Hill World News

682-Mile, single-circuit, steel-tower line to transmit 700 Mw to Buenos Aires from remote hydro site.....p 64

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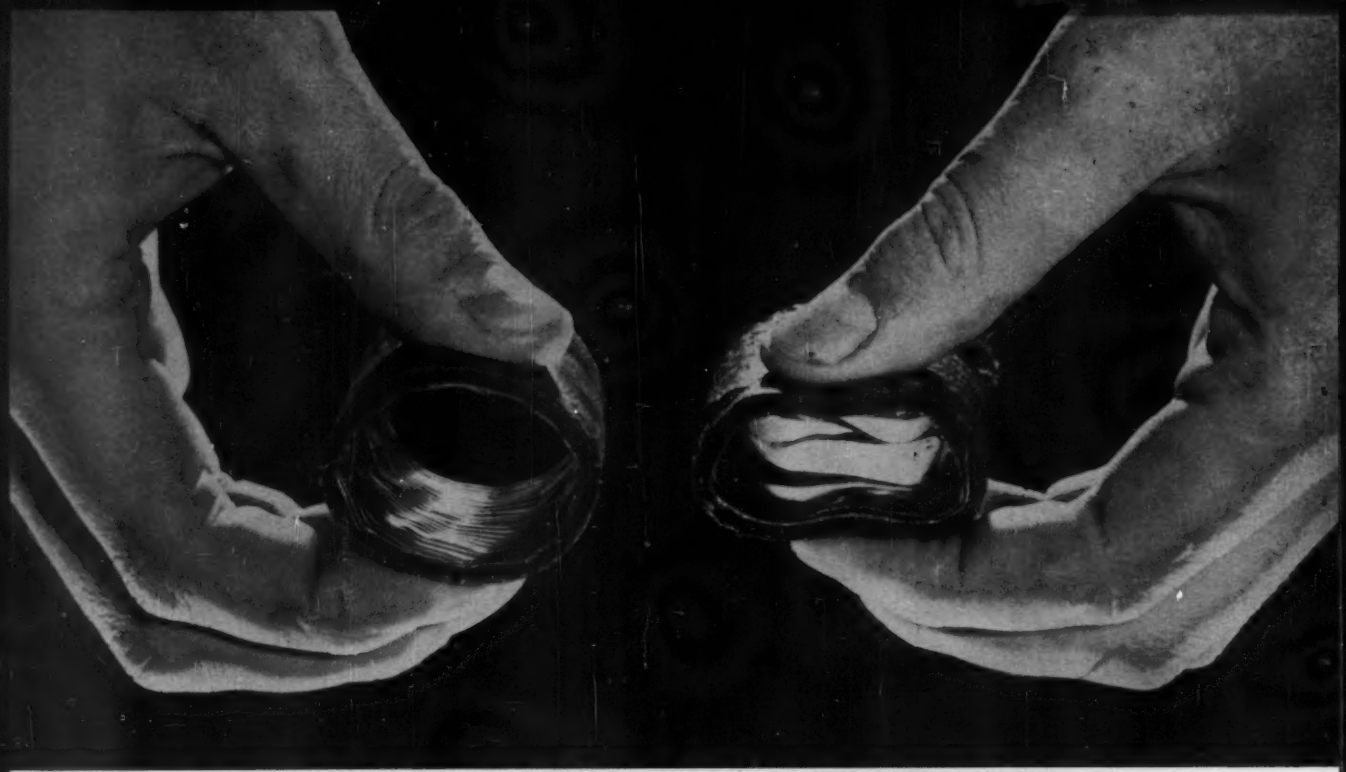

PROVE IT FOR YOURSELF. CM-OT finish (left), with helically-wrapped corrugated bronze tape, withstands compression to a much greater degree than a Parkway-type finish with a flat metal tape twice the thickness (right).

CM-OT* gives more compressive strength with half the thickness of metal tape

Now you can have a high strength cable covering without resorting to bulky or hard to train direct burial constructions. Okonite CM-OT covering provides a light weight, flexible, small diameter cable of great compressive strength. It offers an excellent combination of installation and maintenance savings for many types of cables—control, communication, power or lighting.

Originally designed for direct burial, CM-OT cables are also readily installed aerially, in conduit, in racks or in underground ducts . . . permitting you to stock one type of cable for many uses.

The corrugated bronze tape that's the heart of the cable covering is permanently bonded to a tough wall of Okoprene, with an Okoprene-filled tape applied overall. This composite covering—bronze plus neoprene—provides a barrier against rodents, termites, moisture, oils or sunlight as well as corrosion by soil alkalies and acids. CM-OT also acts as a two-way cushion and "shield" against the stress of shifting stones and mechanical impact that might damage the vital conductor insulation in service. Electrically, the bronze tape serves as an excellent shield, and "ground" where necessary.

Where your environmental conditions demand different corrosion-resistant properties, CM-PF finish is available with Okoseal (polyvinyl chloride) or Okolene (polyethylene) bonded to the corrugated bronze tape instead of Okoprene. This should be considered particularly where petrochemicals are present.

Flexible . . . easy to handle, splice and terminate—CM-OT is a quality construction you'll find it profitable to become better acquainted with. For the full story, including actual test figures on the samples in the photograph, send for Bulletin EW-1121, The Okonite Company, Passaic, New Jersey.

Corrugation = strength plus lightness
Just as corrugated construction adds strength to underground pipes, so corrugation of shielding tape permits the construction of a stronger, lighter, more flexible and more easily handled cable—CM-OT.

*Patent No. 2722562

where there's electrical power . . . there's **OKONITE CABLE**

6130-A

From Whence Good Business

GROSS NATIONAL PRODUCT—1958*

(billions)	1st Qtr	Increase by 4th Qtr	4th Qtr
Federal government spending (including military)	$49.7	+3	(about) $52.5
State and local spending	38.3	+2	40.5
Housing	14.3	+1	15.0
Consumer spending	281.0	+3	284.0
Capital goods (including farm equipment)	46.7	−6	41.0
Investment abroad (net)	1.5	−0.5	1.0
	431.5	+2.5	434.0
Less: Reduction in inventories	−7.5		−4.0
Total GNP	424.0		430.0

*seasonally adjusted annual rates

Everyone is asking when business will improve. But the fact of the matter is that the improvement must come from some stimulus. In 1954 we came out of the recession because of a healthy increase in capital spending and residential construction. What have we to look forward to today in the way of a stimulus?

One thing seems certain. There is nothing in view that can provide a rapid improvement in business in general. But our Economics Department has put together the table (left) which shows how business activity may be able to emerge from the present slump.

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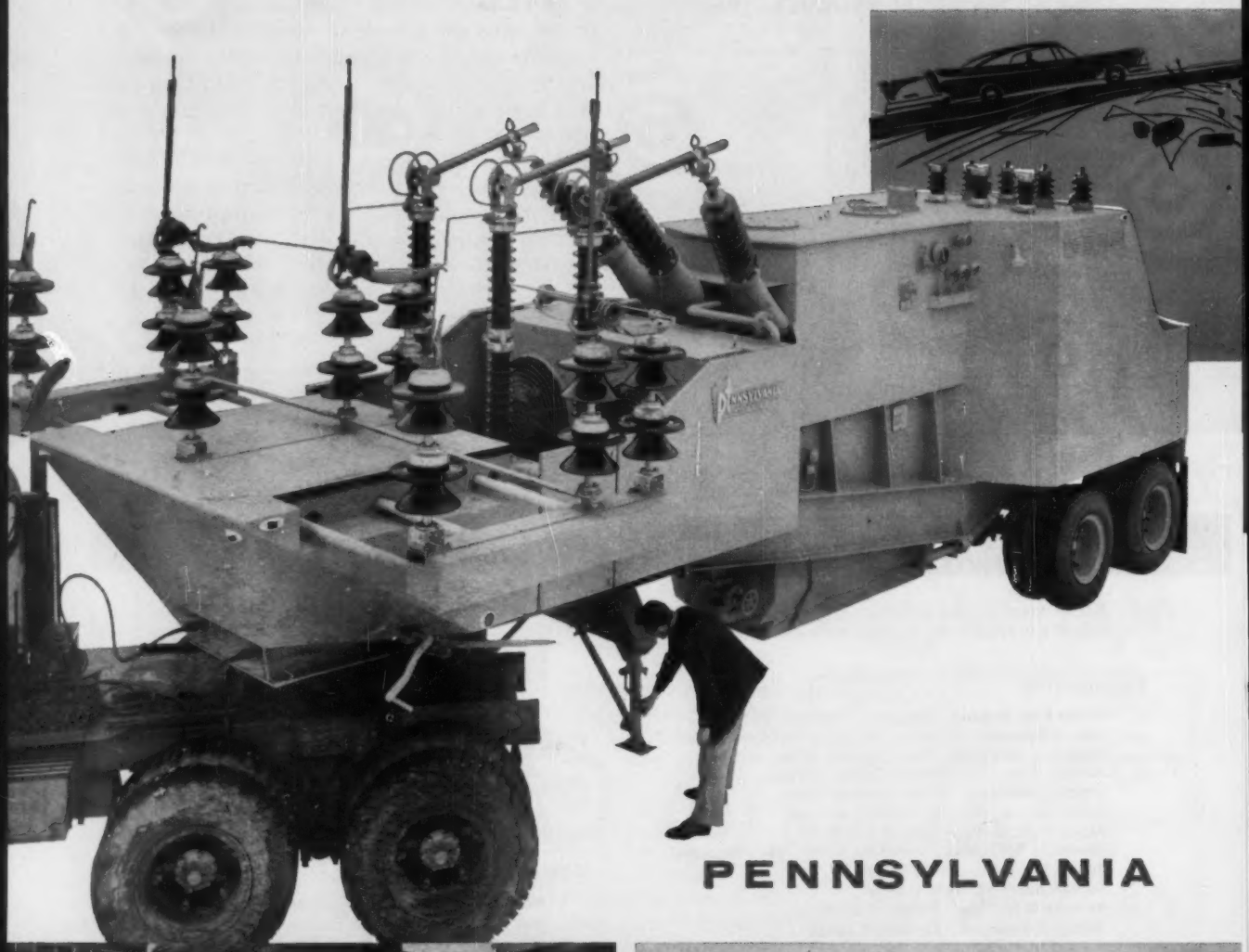
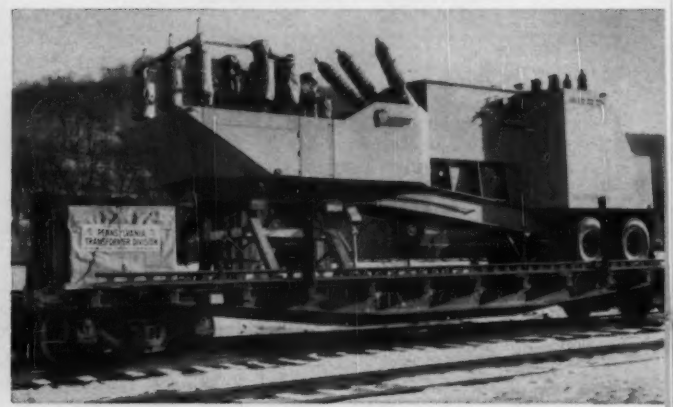
NEW 15000 KVA PENNSYLVANIA



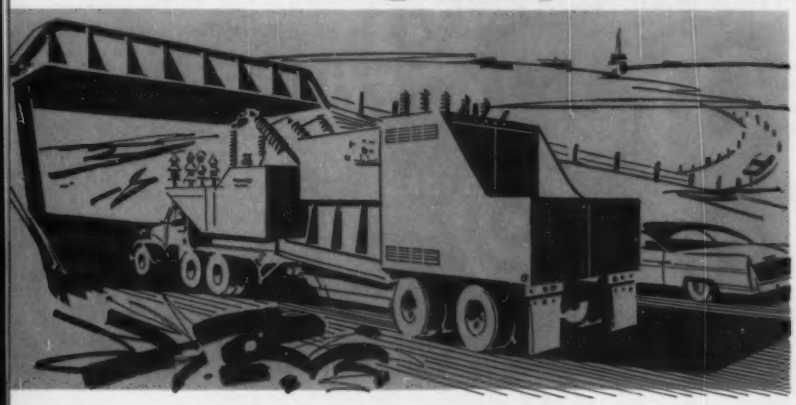
PENNSYLVANIA

The rear compartment and platform of Pennsylvania's new Transmobile provide easy access to the low voltage circuit breaker, control equipment, metering devices, etc.



Shipped by rail, the Transmobile was unloaded by backing a tractor under the trailer and driving it down a ramp. The 15000-kva unit was shipped fully assembled.

MOBILE SUBSTATION meets normal highway clearances . . .



Pennsylvania "Transmobile" speeds complete substation service wherever it's needed

One of the highest-capacity mobile substations in the United States now rolls over the highways of a southwestern utility to wherever it is needed for emergency or maintenance service. This substation on wheels, a new Pennsylvania Transmobile, also serves as a replacement unit for the utility whenever permanent facilities are being altered or enlarged.

Designed and built by Pennsylvania Transformer, the three-phase, 15,000-kva Transmobile has a high voltage of 64,400△ volts, with two full-capacity taps above and two below normal. The low voltage is 12,470Y/7200 volts.

The substation includes a high voltage air-break switch, which is retractable when the Transmobile is being moved, high voltage and low voltage lightning arresters, metering and auxiliary power transformers, metering current transformers, a low voltage oil circuit breaker, a phasing transformer, and high voltage fuses.

Mobility of the Pennsylvania Transmobile is excellent, despite its high capacity and complete complement of substation equipment. With high voltage fuses removed, all three dimensions meet normal highway clearances. Only the weight exceeds normal highway limitations—but the total weight is well within the maximum agreed upon between the utility and the state.

Pennsylvania Produces All Types and Sizes of Custom-Designed Mobile Substations

Putting power on wheels is nothing new for Pennsylvania Transformer, whose experience with mobile units ranges from small distribution transformers to fully equipped substations like the one shown. A 15,000-kva mobile autotransformer (138—69 kv) is now under construction for the same southwestern utility.

If you are considering adding mobility to your own system, a consultation with Pennsylvania's experienced engineers will not obligate you in any way. Contact Pennsylvania Transformer Division, McGraw-Edison Company, Box 330, Canonsburg, Pa.

POWER TRANSFORMERS

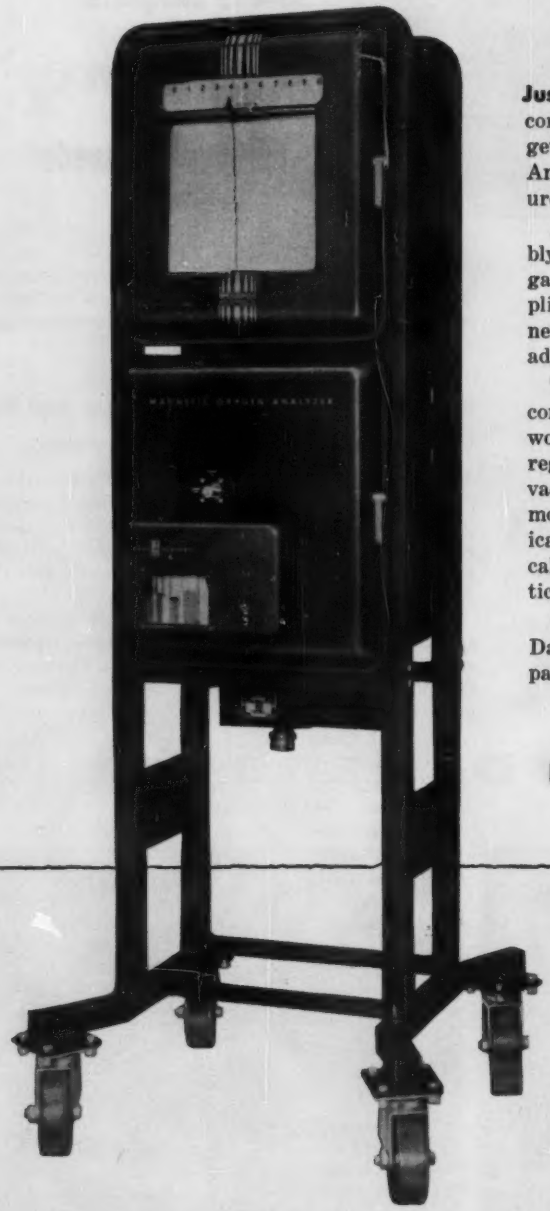
5000 KVA PENNSYLVANIA MOBILE SUBSTATION
High voltage: 11500△ x 34500 volts. Low voltage: 2520/4360Y/2520 x 7560/13090Y/7560 volts.

3750 KVA PENNSYLVANIA MOBILE SUBSTATION
High voltage: 25700 x 51400△ volts. Low voltage: 2520/4360Y/2520 x 5040/8720Y/5040 x 7560/13090Y/ 7560 volts.

GET O_2 DATA...

with new flue gas analyzer

ANYWHERE...ANY TIME...



Just roll this Magnetic O_2 Analyzer Recorder up to any sample pick-off point and get continuously recorded excess air data. And it's accurate data, for complete measurement is by direct magnetic action.

Already, operators are using the assembly for many purposes . . . checking flue gas stratification, verifying regular sampling points, exploring the suitability of new sampling points, checking for burner adjustment.

This rugged assembly is designed for continuous day-after-day operation . . . works from any 115-volt, 60 cycle nonregulated power source . . . has its own vacuum pump and sample cleaning filters mounted on the rear . . . doesn't need chemical reactions or auxiliary gas supplies for calibration and operation . . . requires practically no set-up time.

For more details write for Preliminary Data Sheet 463-61. Leeds & Northrup Company, 4938 Stenton Ave., Phila. 44, Pa.

LEEDS NORTHRUP
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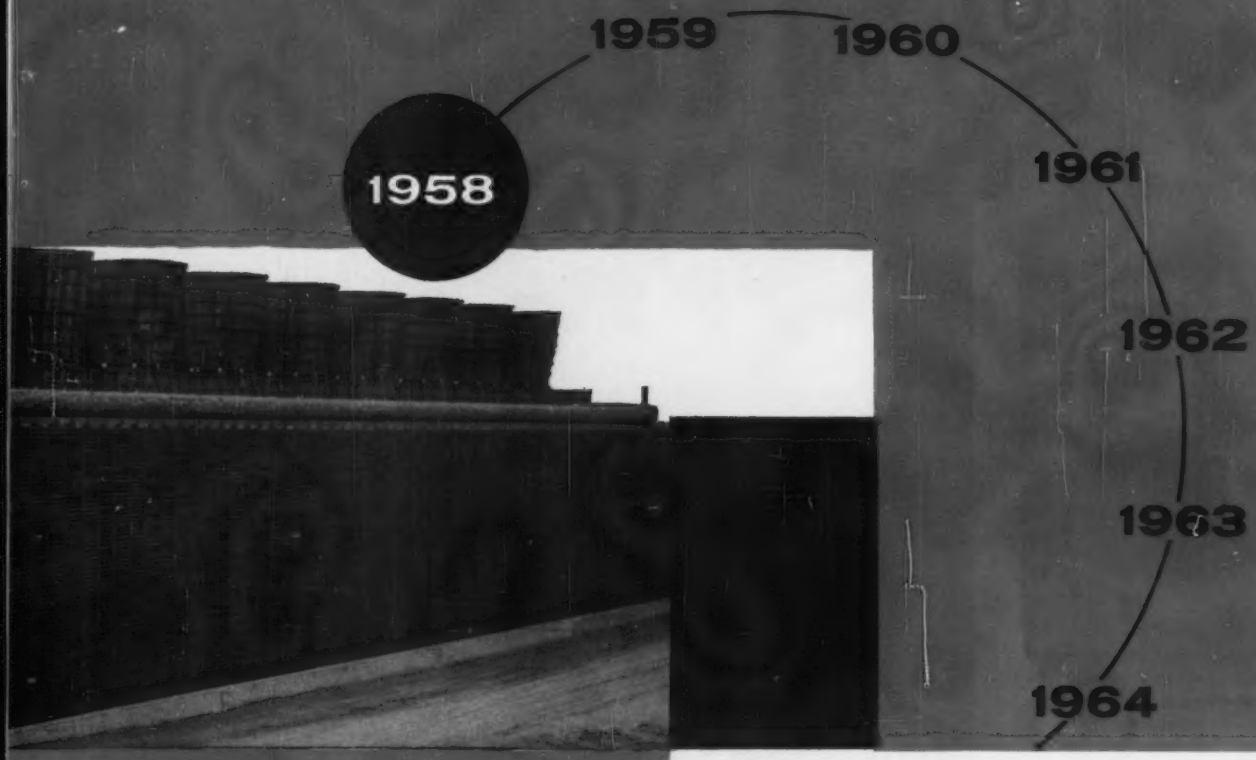
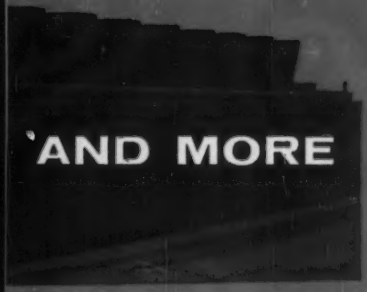
PERFORMANCE

Range	0 to 5% O_2, 0 to 10% O_2, or higher in flue gas as specified
Accuracy	0.15% O_2
Sensitivity	Better than ±0.05% O_2
Stability	Better than ±0.15% O_2
Response	Initial response at Analyzer, 4 sec.; to 90% of full scale at Analyzer, 30 sec. Typical sampling lag, 1 sec. per 6 ft. of ½" plastic tubing

protected from fungal decay

now . . . and for years ahead





All of the 1,715,000 board feet of lumber used in constructing the mammoth Clinch River Station cooling towers of the Appalachian Power Company at Carbo, Va., was pressure-treated with Koppers chemical preservatives to protect it against the development of fungal decay, the most frequent cause of early tower failures. Koppers pressure-treatment was specified for this important installation, because Koppers methods and preservatives assure tower lumber a maintenance-free life expectancy many times longer than that of untreated redwood.

As pioneers in the development and perfection of wood preservative chemicals and techniques, Koppers has successfully treated more cooling tower lumber than any other company in the United States. Koppers many years of scientific and technical experience are your positive assurance of the *best* in lumber protection.

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Company_____

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A NEW WRINKLE IN NETWORK DESIGN

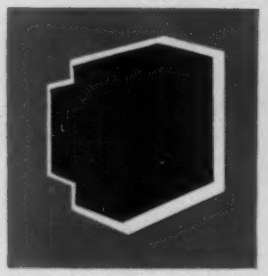
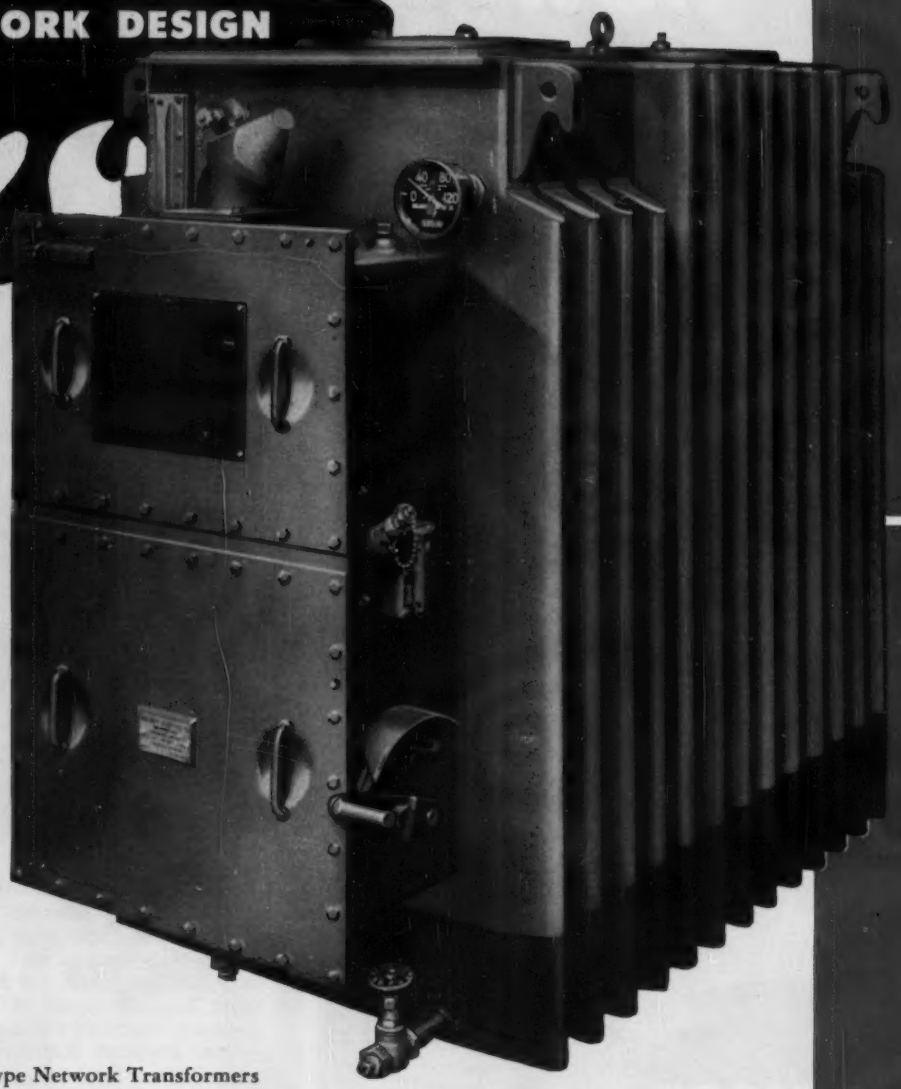


Diagram illustrates savings in space of new design as compared with older type network transformer.



Moloney Subway or Vault-Type Network Transformers with corrugated tanks are strong, rugged units developed by Moloney to answer some of the problems associated with the use of network transformers.

These units are built to conform to the EEI-NEMA Standards for Network Transformers or to conform to customers specifications.

Moloney Network Transformers offer your system the performance, dependability and trouble-free service expected of all Moloney products . . .
Specify Moloney Transformers for Quality . . . All Along The Line.

MEDD-13

MOLONEY ELECTRIC COMPANY

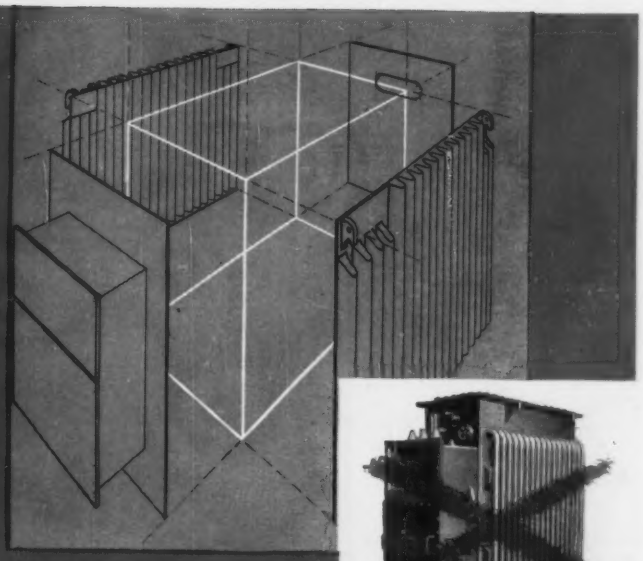
Manufacturers of Transformers for Utilities, Industry, and Electronic Applications

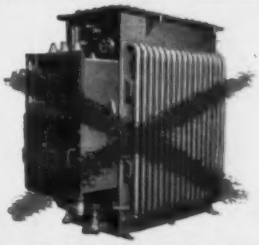
SALES OFFICES IN ALL PRINCIPAL CITIES • FACTORIES AT ST. LOUIS 20, MO. AND TORONTO, ONT., CANADA

REAL TANK CORRUGATIONS

Moloney Network Transformer tank walls are really corrugated (as shown in diagram) and are welded only at the corners.

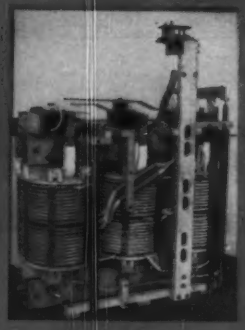
The old problems of corrosion spots and servicing accessibility are gone; now inspection, cleaning and painting is easily done from above.





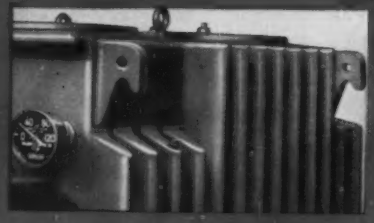
RUGGED CORE-AND-COIL UNIT

The core-and-coil assembly is a rugged, compact unit solidly blocked and framed. Every lead is adequately insulated and rigidly braced. All bus bars are supported by stand-off insulators. The core-and-coil unit is securely fastened into its position in the tank by adjustable clamps.



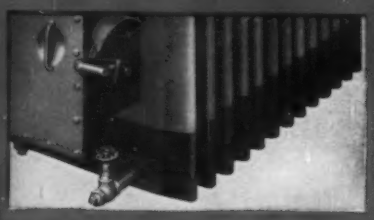
INCREASED MECHANICAL STRENGTH

Moloney's ability to corrugate the steel plates of the transformer tank wall produces a tank of inherently greater mechanical strength, thereby eliminating the need for cross bracing.



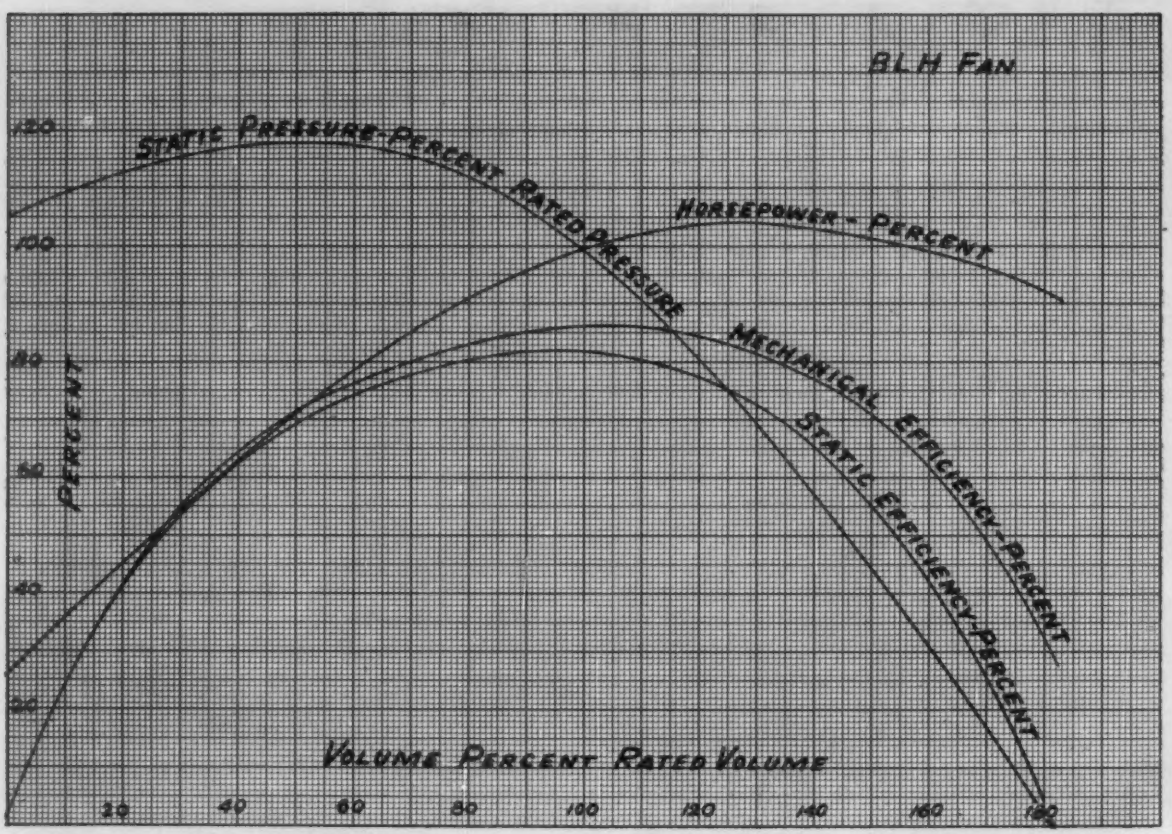
SEALED AGAINST MOISTURE

Tank covers and openings are welded in, absolutely sealing the tank against the entrance of moisture.



UNDERCOATING OF TANK BASE AND LOWER TANK WALLS

Maximum protection against rust and corrosion is obtained by the application of protective undercoating extending up the tank walls to a point above the normal level of submersion.



When Mechanical Draft Specs meet them with "BUFFALO"

To enjoy the efficiency benefits of the "BLH" in Classes III and IV mechanical draft installations, contact your nearest "Buffalo" representative — or write for Bulletin F-200.

"BLH"—For Classes III & IV Mechanical Draft Service

The "Buffalo" Type "BLH" Fan is specifically designed to deliver peak efficiency, dependability and serviceability for Classes III and IV mechanical draft requirements. The "BLH" maintains its high mechanical efficiency of 86% over an extremely broad operating range. The "BLH" insures a constant stability of performance from free delivery to shutoff. Many unusual design features contribute to the smooth, quiet, powerful operation of the "BLH". A smooth inlet bell, directional inlet vanes, backward curved blades, specially curved rotor flange and divergent outlet reduce turbulence to an absolute minimum.

You'll appreciate the "Q" Factor in all "Buffalo" Fans — the built-in

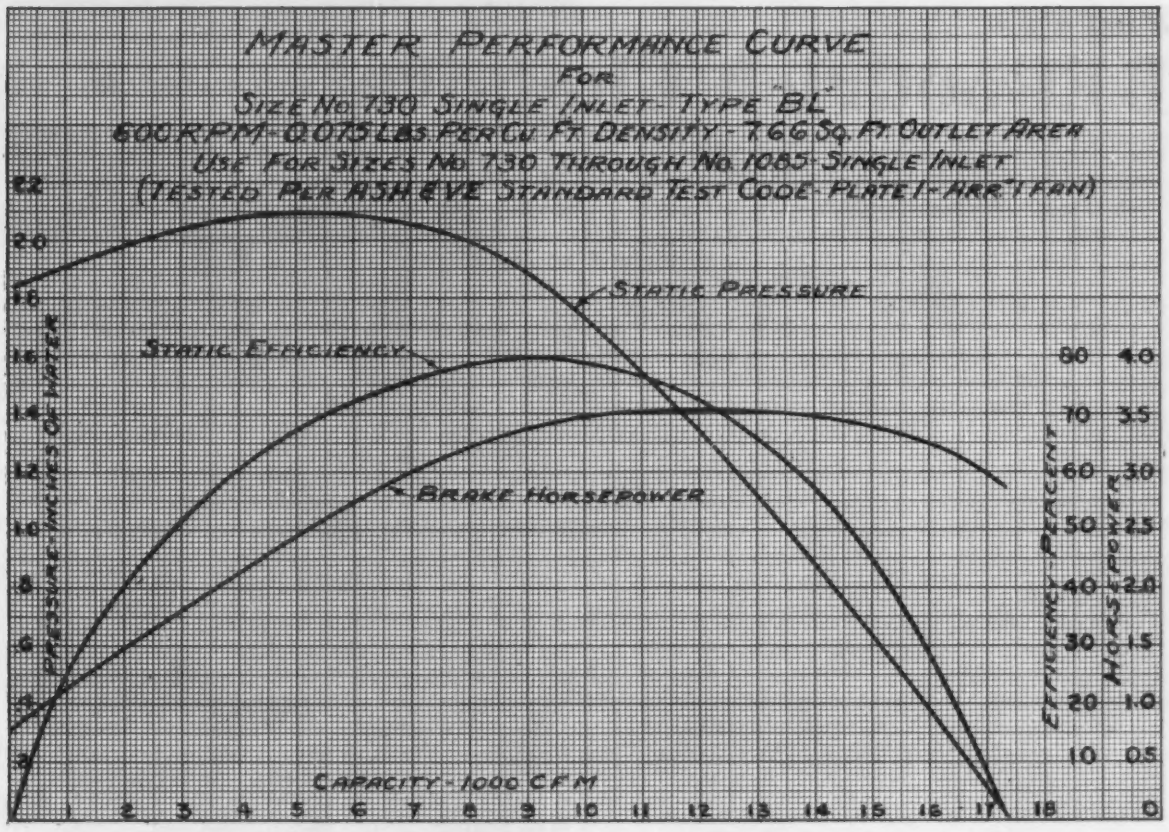
"Buffalo"

BUFFALO

BUFFALO,

Canadian Blower and Forge

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING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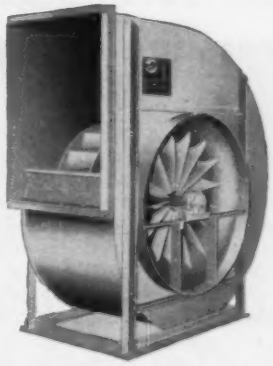
FOR
SIZE NO. 730 SINGLE INLET - TYPE "BL"
600 RPM - 0.075 LBS. PER CU. FT. DENSITY - 7.66 SQ. FT. OUTLET AREA
USE FOR SIZES NO. 730 THROUGH NO. 1085 SINGLE INLET
(TESTED PER AMCA & ASHRAE STANDARD TEST CODE - PLATE 1 - ARR'T 1 FAN)
STATIC PRESSURE
STATIC EFFICIENCY
BRAKE HORSEPOWER
PRESSURE INCHES OF WATER
EFFICIENCY PERCENT
HORSEPOWER
CAPACITY - 1000 CFM

call for flexible fan performance types "BL" and "BLH" fans

"BL"—For Classes I & II Mechanical Draft Service

The "Buffalo" Type "BL" Fan will provide superior performance for most mechanical draft requirements in Classes I & II. Of non-overloading design, the "BL" insures quiet, stable output from free delivery to shutoff. The high operational efficiency of the "BL" is directly due to several unique design features. Minimum turbulence is a result of the smoothly curved inlet bell with directional guide vanes. Among other outstanding "BL" features are the correctly-designed wheel, tested and balanced at the factory to keep vibration to a minimum, and the specially shaped scroll of the "Wheel-matched" housing.

Quality which provides trouble-free satisfaction and long life.



For top performance under general requirements in Classes I and II mechanical draft service, ask your nearest "Buffalo" representative about the "BL" Fan, or write today for Bulletin F-102.

FORGE COMPANY
NEW YORK
Co., Ltd., Kitchener, Ont.

FORCED DRAFT COOLING HEATING PRESSURE BLOWING

News about

B.F.Goodrich Chemical *raw materials*

Sanford station of Florida Power & Light Company uses Geon conduit furnished by Hughes Supply of Daytona Beach. B.F.Goodrich Chemical Company supplies the Geon polyvinyl material only.

corrosion problem knocked out . . .

generating station gets conduit of Geon

YEARS from now pulling new cable through this conduit made from Geon polyvinyl materials will be just as easy as it is today. Unlike ordinary steel conduit, Geon conduit resists the corrosive effect of salt water, gases, chemicals and acid or alkaline soils. Internal and external surfaces stay smooth—like new.

Conduit or pipe made from Geon offers high tensile or impact strength. It stands up under pressure . . . is not subject to galvanic corrosion. It resists sunlight, fungi, bacteria, moisture, heat and cold. And its light weight makes installation especially easy.

Engineers are taking advantage of properties of pipe and conduit of Geon in a wide variety of applications. For information, write Dept. LR-6, B.F.Goodrich Chemical Company, 3135 Euclid Ave., Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ont.

B.F.Goodrich Chemical Company
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GEON polyvinyl materials • HYCAR American rubber and latex
GOOD-RITE chemicals and plasticizers • HARMON colors

They packed up turbine oil worries at Alton Box Board

six turbines use NONPAREIL Turbine Oil, have life-of-turbine guarantee

Six NONPAREIL Turbine Oil guarantee certificates on the turbine room wall are pointed out by M. D. Jones, Superintendent of the Power and Steam Department. Standard Oil Company's lubrication engineer, W. P. "Sandy" Wehking, helped put most of the certificates there.

Alton Box Board Company, Alton, Illinois, doesn't have a worry in the world about turbine oil. The Company has six turbines in service—four in the power plant and two in the paper mill—all using NONPAREIL Turbine Oil. Why no worries? Because each of these fills of turbine oil is *guaranteed for the life of the turbine* not to exceed a neutralization number above 0.15 mg. KOH/g.

The five Westinghouse and one G-E turbine oil fills have demonstrated a remarkable low acidity record over the years. Regular inspection by Standard Oil technical service representatives and analysis of oil samples by the Standard Oil Research Laboratory, Whiting, Indiana, makes sure the oil is performing in accordance with the guarantee. At Alton Box, neutralization number of the oil has been running 0.02 to 0.03 mg. KOH/g.

This is what such service from a turbine oil means to Alton Box Board: They can run one of the largest board mills in the world without having to concern themselves with the performance of the turbine oil they are using. Standard Oil technical service men inspect the system. The oil is sampled and analyzed regularly. Plant operation will never be interrupted because of turbine oil lubrication failure.

The same performance from NONPAREIL Turbine Oil and service from Standard Oil awaits you. Find out. Call your nearby Standard Oil office near you in any of the 15 Midwest and Rocky Mountain states. Or write Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

How NONPAREIL Turbine Oil is performing at Alton Box Board

Make of Turbine	kw. (H.P.)	Year NONPAREIL Installed	Location	Gal. fill.	Neut. No. mg. KOH/g.
Westinghouse	1,500	1934	Power Plant	85	.02
Westinghouse	3,125	1936	Power Plant	275	.03
General Elec.	400	1936	Paper Mill	50	.02
Westinghouse	1,500	1941	Power Plant	250	.03
Westinghouse	5,000	1947	Power Plant	230	.03
Westinghouse	1,500	1947	Paper Mill	80	.02

Discussing lubrication. Sandy Wehking, Standard's man on the Alton Box Board account, is well qualified to do so. He's been at this work for 15 years. Sandy studied chemical engineering at Blackburn College. He has also completed the Standard Oil Sales Engineering School.

STANDARD

STANDARD OIL COMPANY (Indiana)

Field experience proves performance advantages of Preformed splices

In hundreds of thousands of applications, only one failure of a Preformed splice has been reported—and that was caused by inadequate preparation of a heavily corroded conductor.

This distinctive performance is the result of soundly engineered features: (1) uniform radial pressure of the splice rods; (2) full area of contact; (3) the flexibility of the rods which causes the grit particles to penetrate existing oxides and establish permanent electrical contact with the conductor; and (4) the inherent resiliency of the splice which maintains consistent surface contact with the conductor throughout extremes of line tension and temperature variation. These combined characteristics are your assurance of unfaltering mechanical and electrical performance at all times.

And, most important, no tools are needed to install a Preformed splice; the application is made entirely by hand and takes but a fraction of the time required for other types of splices.

There are Preformed splices to solve almost every splicing problem. They can be furnished to hold the full-rated strength of any standard transmission or distribution conductor.

Write for additional technical information. PREFORMED LINE PRODUCTS COMPANY, 5349 St. Clair Avenue, Cleveland 3, Ohio. Cable Address: Preformed-Cleveland . . . manufacturer of armor rods, dead-ends, Guy-Grip dead-ends and other line accessories.

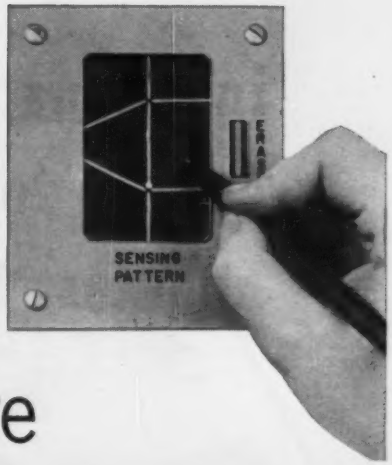
PLP

10 YEARS OF Power Line Progress

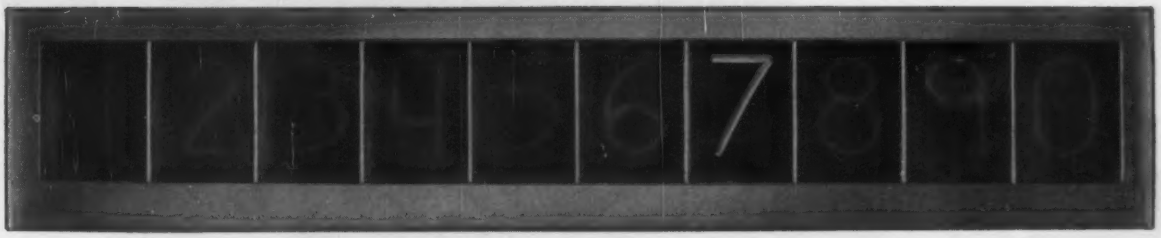
You can look up to **Preformed**

Made in accordance with or for use under U.S. Patent Nos. 2,609,653; 2,275,019; 2,587,521; and 2,691,685. Other patents pending.

Write a numeral here



and read it here



on new Bell Labs machine

A new device invented at Bell Laboratories "reads" a numeral while it is being written and instantly converts it into distinctive electric signals. The signals may be employed to make a numeral light up in a display panel, as above, or they may be sent to a computer or to a magnetic "memory" for storage.

The writing is done with a metal stylus on a specially prepared surface. Two dots, one above the other, are used as reference points. Seven sensitized lines extend radially from the dots. Transistorized logic circuits recognize numerals according to which lines are crossed.

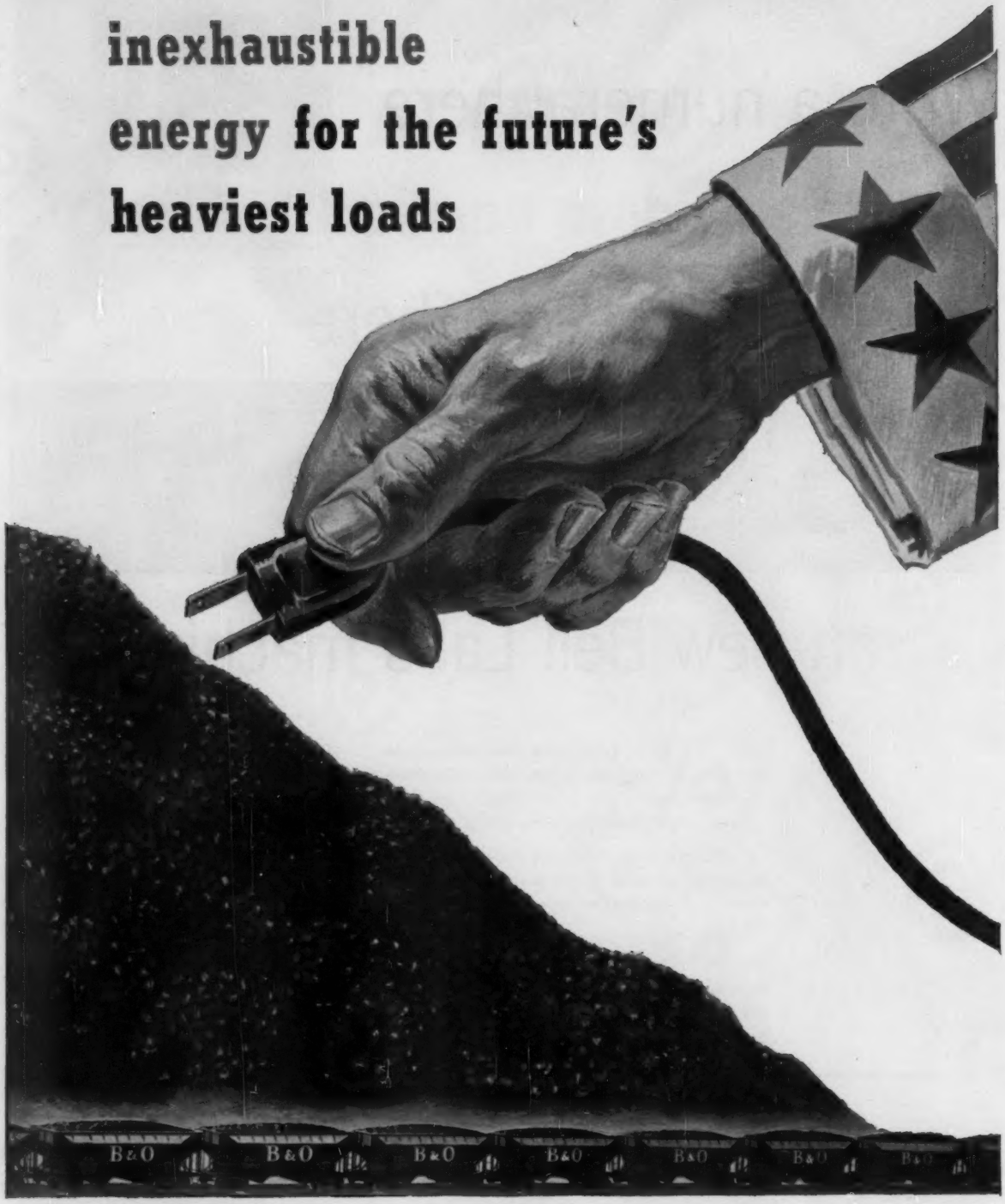
The concept of a number-reader has interesting possibilities as a new means of communication from humans to machines. For example, in an adjunct to a telephone, it might provide inexpensive means of converting handwritten data into signals which machines can read. The signals could be transmitted through the regular telephone network to a teletypewriter or computer at a distant point. In this way, a salesman might quickly and easily furnish sales data to headquarters, or a merchant might order goods from a warehouse.

Modern communication involves many more fields of inquiry than the transmission and reception of sound. The experimental number-reader is but one example of Bell Telephone Laboratories work to improve communications service.

Tom Dimond, a B.S. in E.E. from the University of Iowa, demonstrates an experimental model of his number-reading invention. A similar device can also be made to read alphabetical characters. Small size and low power requirements result from transistor circuitry.

BELL TELEPHONE LABORATORIES
World Center of Communications Research and Development

inexhaustible energy for the future's heaviest loads



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Many companies keep up-to-date on constantly changing insurance problems by calling in Ebasco for periodic surveys. It helps them get the most insurance protection at lowest costs.

For information about these services, send for our brochure, "How To Get The Most Out of Your Business Insurance Program," Ebasco Services Incorporated, Dept. M, Two Rector Street, New York 6, New York.

Challenging career opportunities now available for qualified engineers. For further information, write to our Personnel Director.

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CADWELD ALUMINUM ELECTRICAL CONNECTIONS

NEWEST ENTRY AN

NEW

CADWELD ALUMINUM (A-22) PROCESS

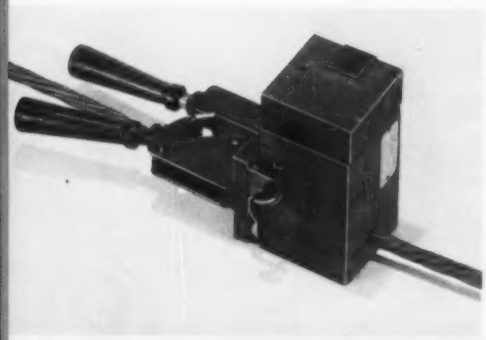
Welds

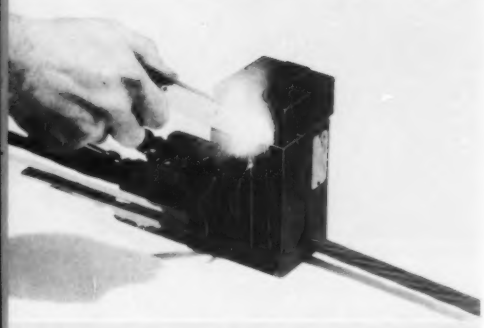
Aluminum to Aluminum

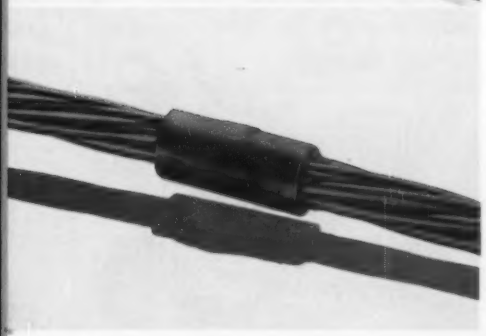
Aluminum to Copper

D SURE WINNER
IN THE ELECTRICAL INDUSTRY

with this light weight portable equipment you can SOLVE your aluminum electrical connection problems







1. NO CREEP—not dependent on mechanical pressure.
2. LOW RESISTANCE—a solid molecular weld.
3. TRANSITION WELDS TO COPPER—no specialized expensive equipment required.
4. EXTREME PORTABILITY—no outside power source required.

CADWELD Aluminum Connections available on:

1. CABLE . . . #4 - 2000 MCM
2. BUS BAR . . . ⅛ x ½ - ½ x 10
3. IPS TUBE . . . ½" - 3"

(or combinations of the above)

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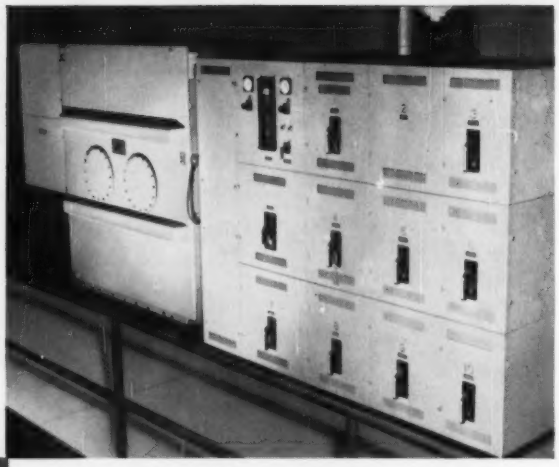
Erico Products, Inc.

2070 E. 61st Place Cleveland 3, Ohio

IN CANADA: ERICO INCORPORATED, 3571 Dundas St., West, Toronto 9, Ontario

Schlitz

adds power capacity ...modernizes distribution system with WAGNER TRANSFORMERS



This is one of the Wagner-equipped unit substations that modernize power distribution at Schlitz. The Wagner Sealed Dry-Type Transformer is rated 1000 kva.

Jos. Schlitz Brewing Company, Milwaukee, Wisconsin.

A continuing program of modernization is one of many reasons why the Jos. Schlitz Brewing Company is a leader in industry. Plant power distribution, for example, has been modernized and expanded to assure an uninterrupted flow of electric power for production of "The Beer That Made Milwaukee Famous."

Schlitz chose Wagner Sealed Dry-Type Transformers for their power distribution load centers. These modern unit substation transformers can be safely installed in any load center—any place—because they are hermetically sealed in welded steel cases to provide positive protection from contamination, fire and explosion hazards. The only maintenance they require is a periodic checking of gas pressure (inert nitrogen), case and bushings.

Wagner Sealed Dry-Type Transformers can serve your power needs just as they do at Schlitz. They are "Predesigned"—coordinated with the specifications of unit substation builders to save job engineering, time, and money. Consult the nearest of our 32 branch offices, or write for Bulletin TU-214 for full information.

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SERVING INDUSTRY SINCE 1891

...to help America LIVE BETTER—*Electrically*

LIVE BETTER ELECTRICALLY

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WT58-9

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

The Electrical Week

FUTURE NEWS ▶ Nebraska citizens may vote in November on a proposed state constitutional amendment calling for a 5% tax on electricity sales.

LATE NEWS ▶ **A giant power pool is being studied seriously** by power suppliers in seven midwestern states. Pool would save over $110 million in generating costs, $10 million/yr in operating costs in next 14 years, delegates to Eastern Missouri Basin Power meet were told.

AEC shelves Wolverine (Mich.) Electric Co-op's reactor project, (aqueous homogenous of 10 Mw,e). Project bogged down when Foster Wheeler notified AEC it would proceed only on a cost basis.

Ike nominates John B. Hussey as FPC member to replace S. L. Digby, whose term ends June 22. The Louisiana Conservation Commissioner, if he wins Senate unit's okay, would be only Democrat on FPC.

Sales jumped 80% during "Best Appliance Values—Better Buy Now" promotion in Fox Cities, Wis. Major appliance sales tripled for dealers who went after business, according to a "mystery shopper" survey taken in the nine-day campaign.

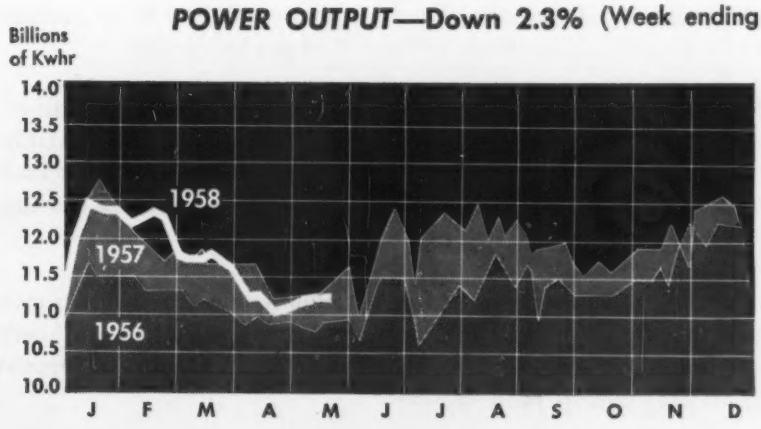
AEC's '59 budget request of $71.5 million is "shockingly low" for basic research, charges Rep Melvin Price (D-Ill.), chairman of JCAE's research and development committee.

Boston Edison gets Department of Public Utilities approval to up rates $2,288,000 a year, or about $1.2 million after taxes.

Management changes . . . Iowa PS elects G. A. Neal chairman; C. R. Beddows vice chairman and controller; E. M. Raun, president . . . Duquesne Light Board Chairman Philip Fleger assumes added duties as president. He succeeds Pressly McCance, who retires July 1.

Obituary . . . Ralph H. Teed, 60, executive vice president of Arkansas P&L, died suddenly in Little Rock of a heart attack.

POWER OUTPUT—Down 2.3% (Week ending May 17), Kwhr 11,257,000,000



Per Cent Change From Previous Year

	May 3	May 10	May 17
Total U.S.	−0.3	−0.0	−2.3
New Eng.	+3.0	+2.9	+0.1
Mid. Atlantic ..	+0.7	+1.6	−2.7
Cent. Ind.	−3.2	−2.9	−5.9
West Cent.	+2.5	+0.4	+1.8
Southeast	−0.8	−0.3	−3.3
South Cent. ...	+6.3	+6.6	+1.8
Rocky Mount...	+2.1	+5.9	+6.1
Pacific			
NW	−6.6	−8.2	−7.6
SW	+2.3	+3.1	+5.2

Seasonally Adjusted Index 224.7

Week Ago 226.8 Year Ago 230.2

Atomic Energy Commission requirements—1,050,000,000 Kwhr (Electrical World Estimate). Excluding AEC, Output decrease was 1.6%.

A TWO-MINUTE PREVIEW OF THIS ISSUE

EVENTS ▶ **Rural Electrification Administration marks its 23rd birthday** this month with a campaign for expanded appliance loans, completion of a loan to finance connection of its 5-millionth customer. The stormy early years of the REA are recounted on **p 50.**

Power companies' capacity topped 100 million kw as Tuscon Gas, Electric Light & Power Co spun a new 75-Mw unit May 11 **(p 49).**

Can utility co-ops refuse service to non-stockholders? This problem, now being probed in Indiana, is one of three current developments affecting co-ops. Others are a Kansas ruling which ends a long-standing service dispute and a Wyoming tax decision **(p 51).**

ATOMIC PROGRESS ▶ **To ease Congress' fears over possible nuclear mishaps,** AEC may require A-plant operators to prove they've picked the safest possible site for their reactors **(p 48)** . . . Joint Committee on Atomic Energy holds the future of Parr Shoals demonstration plant in its hands. Hearings will be coming up soon **(p 49).**

EHV TRANSMISSION ▶ **From three continents** come the stories that make up EW's special report on extra-high-voltage transmission. Here are the facts on three major applications of EHV:

A 400-kv backbone in Germany now overlays an old 220-kv grid that ties hydro plants in the Alps with coal and lignite plants throughout the country. Carrying 600 Mw, it gives "the largest transmission capacity at the lowest cost" **(p 56).**

A 345-kv interconnection in the United States, which went into service last week, links Commonwealth Edison to American Electric Power. This EHV hookup will reduce the reserve requirements of each system by 200 Mw **(p 60).**

A 380-kv flyaway line in Argentina, scheduled for completion in 1962, will bring 700 Mw of cheap hydro power down from the Andes to power-hungry Buenos Aires. Route is 683 mi long **(p 64).**

. . . And a bonus—Tennessee Valley Authority tells how it cut average first cost of transmission from $80 to $42.50 per kw **(p 67).**

DISTRIBUTION ▶ **Higher utilization voltages may be the answer** to problems caused by the growth of the all-electric home, the Transmission & Distribution Committee of Pennsylvania Electric Assn was told. Higher load densities associated with electric heating and cooling may also warrant a higher primary voltage **(p 110).**

METERS ▶ **Two electric companies join swing to random-sample testing** on residential single-phase watthour meters, the Pennsylvania Electric Assn's Meter Committee heard. Anticipated savings: up to 50% of present meter testing cost **(p 112).**

RELAYING ▶ **Ratio differential relays got the nod** for a unique application in Ohio. And Detroit Edison plans to equip more transformers with fault pressure and sudden pressure relays. Digital computers can solve tough interconnection problems. These are just a few of the reports relay engineers heard at Illinois Institute of Technology's 1958 Relay Conference held last month. For the full story, turn to p 98.

MANAGEMENT ▶ **Coal will get a bigger slice of the utility fuel market** in 1975 than it does today. EW's study of fuel trends for the next 20 years shows utilities shifting steadily to coal as oil and gas are diverted to premium uses, predicts 1.6 trillion kwhr of coal-fired generation by 1975. Hydro will decline in importance as the need for power multiplies. The high cost of nuclear power will hold its share of generation down to about 4%, and thermonuclear and solar electricity will not be here at all. Part I of a three-part report on the utilities' fuel outlook appears on p 101.

INDUSTRIAL ▶ **A belt conveyor system has ended shoe production bottlenecks** for a Pennsylvania firm, with savings in time and manpower. Before the conveyor, all materials were hand-carried in baskets (p 96).

SELLING ▶ **A bakery in Milwaukee boosted cake sales** by installing 80 ft-candles of new lighting and an air conditioning system . . . A Westinghouse official predicted air conditioners powerful enough to cool a whole house, yet small enough to be carried under one arm, and capable of being installed in minutes (p 94).

MANUFACTURERS ▶ **High-capacity, outdoor air circuit breakers,** unveiled recently by General Electric, are designed with an eye to future EHV transmission. The new line employs a pressurized interrupter principle . . . An adjustable crossarm gain marketed by Malleable Iron Fittings Co of Branford, Conn., handles crossarms from 7 in. to 12 in. (p 71) . . . Consolidated Edison Co is installing eight 3-phase 2,500-kva network transformers—the largest ever built (p 74) . . . At Eddystone Station, Philadelphia Electric Co is installing the first dual-cooled transformer system (p 78).

NEW EQUIPMENT ▶ **Heavy-duty connector comes in three sizes,** covers range from No. 3/0 to 954 Mcm . . . Power recloser interrupts 8,000 amp at 14.4 kv or 12,000 amp at 4.8 kv . . . Electronic fish control guides fish away from tailraces to fish ladders, elevators, or traps without injuring them (p 82).

PEOPLE ▶ **VP Kenneth G. Oxley takes on new duties** as associate general manager at Dayton P&L . . . Westinghouse Electric Corp's three new VP's are J. W. Simpson, T. P. Jones, and R. J. Sargent . . . In shift of top executives, Anaconda makes Clyde Weed board chairman and chief executive officer; Charles Brinckerhoff, president; C J. Parkinson, VP . . . American Brass ups John Coe, Richard Stewart (p 107).

By 1968 nuclear power will become competitive with power from conventional power plants. This prediction is made either by assuming that the historical rate of cost reduction in conventional plants can be applied to nuclear plants or by showing that the cost structure of conventional power is likely to prove unstable in the future and that the instability will lead to a considerable rise in costs.—**J. E. Ullmann, Science, April 4, 1958.**

Microwave radiation is treated with respect by Defense Department personnel although no injuries are charged against it. Precautions applied to high-power radar include prohibiting work on antenna or transmission feeders while on the air, keeping beam away from inhabited areas, and discharging rf into dummy loads during tests. Meanwhile research explores human tolerance to rf radiation and seeks to develop a simple dosimeter to monitor it.—**Electronics, April 18, 1958.**

TECHNICAL NOTES

"Activation" is a major factor influencing the degree of erosion caused by electric arcs where relay contacts are opened or closed. This phenomenon is produced by repeated operation of a pair of current-carrying contacts in the presence of organic vapor. It can be reduced both by using in relay construction stable materials which are not sources of organic vapors and by adequate ventilation.

Disposal of radioactive waste material into salt structures appears, at the present time, to be the best possibility. Considerably more salt is mined annually than the expected future production of high-level wastes.

Thorium is much cheaper than uranium as an atomic fuel. One of the reasons for this is that its chemistry is much simpler.

FROM EDITORS IN THE FIELD

Who is the oldest pole-climbing lineman on your system? Consumer Power Co's Harry Harring is climbing poles at age 64 and has one year to go before retirement. Can you top this example of vitality?

Design of world's largest solar power plant is claimed by Russia. Plant will produce 2.5-million kwhr and 20,000 tons of steam annually, according to the Soviets. Five acres of mirrors will be used.

"Whatever Your Preference in Insulators, O-B Has It"

YOU CAN TIE OR CLAMP YOUR CONDUCTOR TO PINTYPE OR POST AND BE SURE OF COMPLETE RELIABILITY

In the O-B line of insulators, right from distribution level up through sub-transmission and transmission voltages, you'll find insulators to suit every preference.

If you like clamptops with the sure-contact feature that eliminates conductor abrasion and RIV problems, there's the choice between pintype clamptops and post clamptops. If you'd rather tie your conductor, you can choose from several posts and pintypes, depending on exposure conditions.

Look at what's available for 34.5 kv, for example. For ordinary exposure, there are four insulators to choose from -- pintype tie-top, pintype clamptop, post tie-top, post clamptop. There are four more recommended for less severe exposure, and another set of four for severe exposure. That makes a total of 12 different insulators you can buy at 34.5 kv alone.

It isn't our job to tell anyone what insulator to buy. We make all the accepted types. Our only suggestion is that there should be no question about the reliability of the insulators you chose. Insulators are one of the smallest items in the cost of any line. Yet no electrical circuit -- whether it be in portable radio or a 345-kv transmission line -- is any better than the insulation that's installed in it.

Through the years, the reliability of O-B insulators has been definitely established. That's probably why there are more of them in service than any other brand.

Ohio Brass

TURN THE PAGE TO READ ABOUT THE NEWEST O-B INSULATOR...

ECONOMICAL, RUGGED and

NEW POST INSULATOR AVAILABLE FOR VOLTAGES UP TO 25 KV

From the strong, corrosion-resistant malleable iron base, made right in O-B's factory, on up to the wide-conductor-groove tie-top, this new post insulator is built to take care of itself.

It's ready for lightning, sudden temperature change, heavy contamination, rough handling . . . all the abuse that an unprotected distribution insulator encounters. We wouldn't advocate throwing rocks at this post or letting it roll around in the bed of a line truck. But if it does get this sort of abuse, chances are it will come through in serviceable condition. It's that rugged. It's designed for voltages up to 25 kv, and for up to 1500 pounds cantilever loading. Of course, it costs less -- about 20 per cent lower -- than posts designed for higher cantilever loading.

The design has been thoroughly tested for electrical reliability and resistance to puncture. At the O-B high-voltage laboratory, it has withstood impulses of 7000-kv rise per micro-second. Every unit, and that's *every* one, is checked with new ultra-sonic equipment that detects even the smallest internal flaw.

The new post is available in seven and nine-inch (porcelain height) models, with leakage distances of 11 and 15 inches. You have a choice of studs, either 1¾-inches long or seven inches. Also available are mounting brackets for angle positions, pole tops and crossarms.

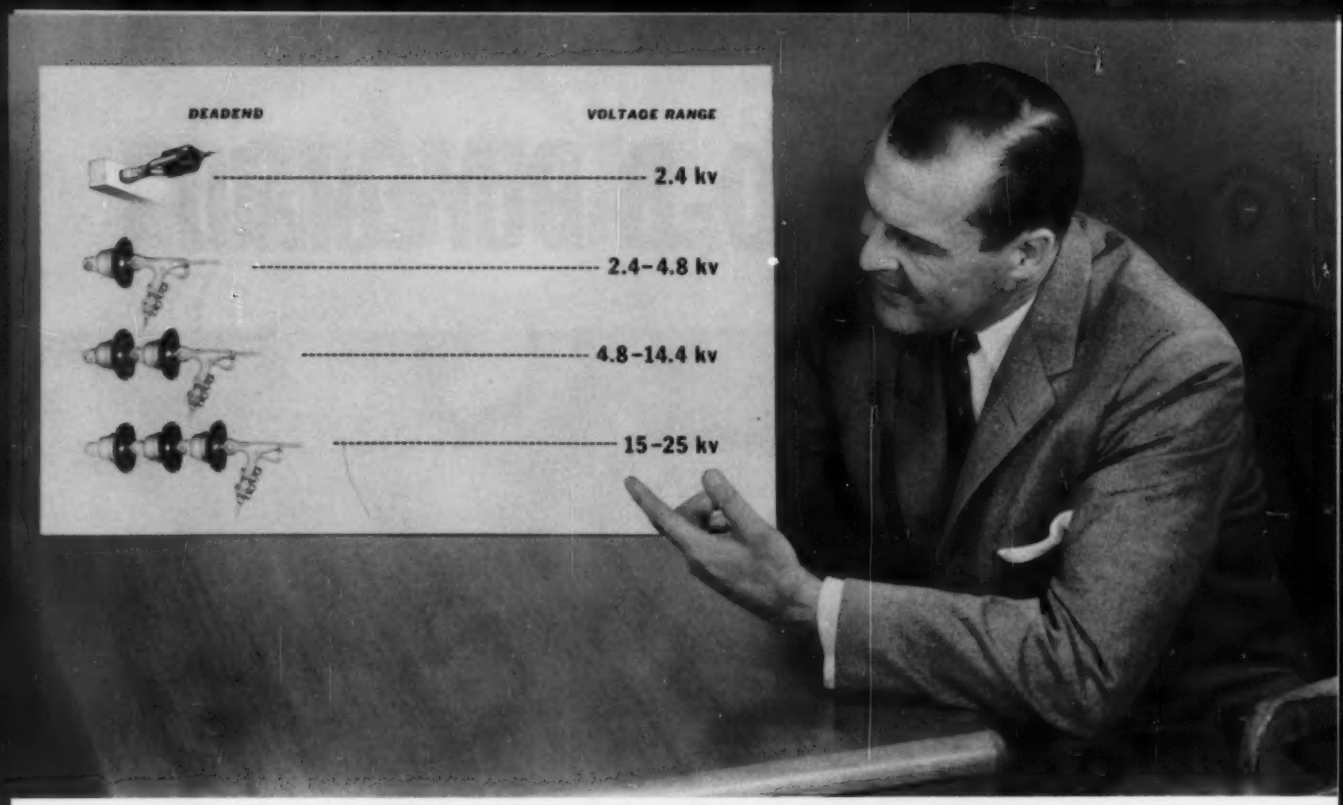
If you're looking for a rugged, low-cost post insulator for distribution service, try these O-B units on your next line. They're available from Graybar.

OHIO BRASS COMPANY, MANSFIELD, OHIO

Very high frequency ultra-sonic vibrations, beamed into solid O-B distribution posts, reveal even the slightest internal defect. Every post is ultra-sonically tested.

Made from O-B Porcelain

Ohio Brass



What Does a "BOLD LOOK" at Tomorrow's Distribution Voltages Show You?

VOLTAGES CAN GO IN ONLY ONE DIRECTION . . . UP

"Take a Bold Look at Distribution" says a headline in one of the power industry's leading magazines.

Have you taken your "bold look" and if you have, what does it show? You know what the residential customers are doing. They're buying ranges, clothes dryers, air conditioners and other "Live Better . . . Electrically" appliances in large quantities.

By 1970 there will be sixty-four million residential customers using 8000 kwhr each annually, according to present forecasts. No wonder many far-sighted distribution engineers are talking about primary residential distribution at a voltage two to four times as high as their present system voltage.

You alone know how high you should go. All we want to do is urge you to make adequate allowance for future loads and to point out that installing extra insulation at dead-ends now will make raising voltages that much easier tomorrow. If provision can be made for existing conductors to serve four to 16 times their present loads, major construction costs can be saved.

We also suggest that the insulators to use are O-B, supplied by Graybar.

OHIO BRASS COMPANY, MANSFIELD, OHIO

LIVE BETTER ELECTRICALLY

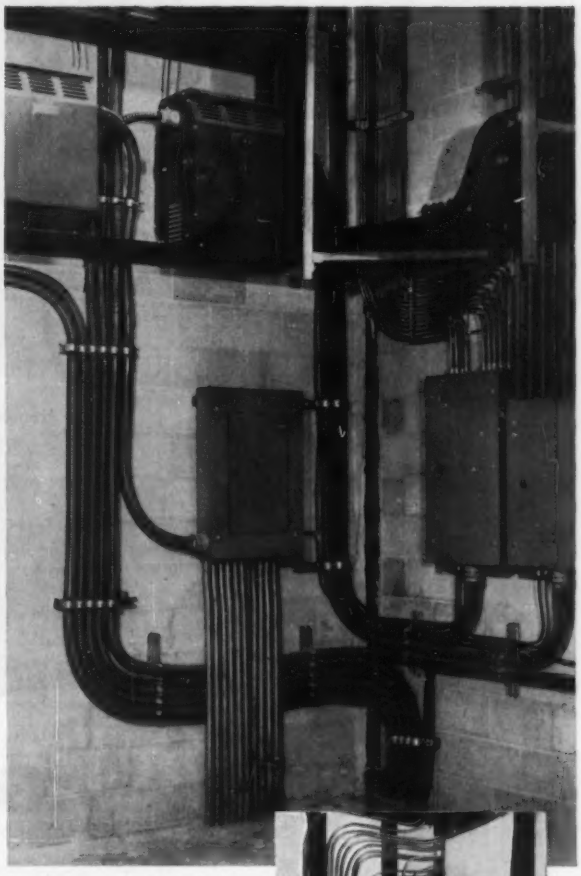
Ohio Brass

GRAYBAR Distributed by GRAYBAR ELECTRIC COMPANY

4884

the right combination for industrial power needs!

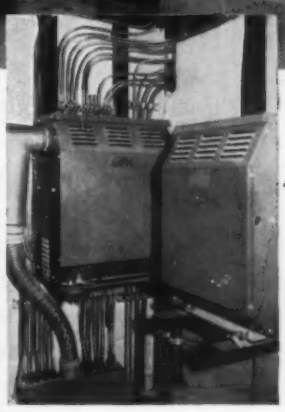
Only General Cable manufactures both...



Installation at the St. Regis Paper Company, Jacksonville, Fla. plant.

TYPE M.I. CABLE

for distribution, control and lighting circuits



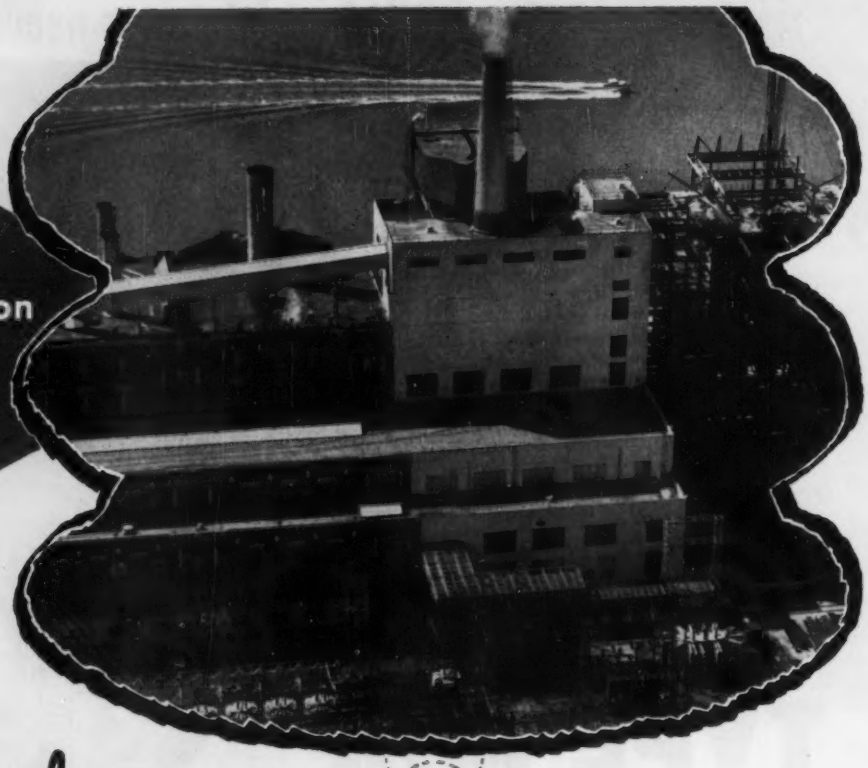
INTERLOCKING ARMORED CABLE

for primary power feeder circuits

Easy to install in all locations, both Safety M I Cable and Interlocking Armored Cable require no mechanical protection, thus lowering costs of installation and minimizing space requirements. These constructions are easy to train around equipment or structural members, assuring the absolute minimum of interference, and present a neat, functional appearance. In addition, Safety M I Cable has unequalled physical and electrical properties: it is completely resistant to moisture, aging, nearly all chemicals, and operates at continuous high temperatures. For truly modern wiring in your plant, specify Safety M I Cable and Interlocking Armored Cable. And remember; only General Cable makes them both.

GENERAL CABLE CORPORATION 420 Lexington Avenue, New York 17, N. Y.
Offices and Distributing Centers Coast-to-Coast

for quality and service... **specify GENERAL CABLE**



INGALLS:
Specialists in Steel Fabrication For Every Structural Purpose

Electrifying GROWTH...

With tremendous population and industry increases challenging the capabilities of the electric power industry, plant expansion is a continuing process.

In 1954 Ingalls furnished 2200 tons of fabricated structural steel and 200 tons of platework for an extension to Jersey Central Power & Light Company's Sayreville Station at Sayreville, New Jersey. Now Ingalls is furnishing another 2200 tons for the '58 extension of this plant. Both extensions were designed by Burns and Roe, Inc., who also supervised construction.

Jersey Central Power and Light Company is one of 46 leading power companies who selected Ingalls to furnish and erect the fabricated steel for their recent extensions.

If your plans call for the strength and economy of fabricated steel, call on Ingalls—specialists in structural steel fabrication and erection for over 48 years.

STEEL PLATE FABRICATORS ASSOCIATION — FOUNDED 1933

AISC — AMERICAN INSTITUTE OF STEEL CONSTRUCTION — FOUNDED 1921

THE
INGALLS
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Executive Offices
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INGALLS INDUSTRIES ARE:

The Ingalls Iron Works Company, Sales Offices: New York, Pittsburgh, Chicago, Houston, New Orleans, Atlanta • **The Ingalls Steel Construction Company,** Sales Offices: New York, Chicago, New Orleans, Pittsburgh, Houston, Atlanta • **Birmingham Tank Company,** Sales Offices: New York, Pittsburgh, Chicago, Atlanta, New Orleans, Pascagoula
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keep an eye on SYSTEM VOLTAGE

SANGAMO LINCOLN THERMAL VOLTMETERS

are the key to economical system planning

Utility engineers need reliable information on system voltage to solve present distribution problems—maintain specific voltage levels—anticipate tomorrow's voltage requirements.

Sangamo Lincoln Thermal Voltmeters are the lowest cost means of obtaining accurate, continuous knowledge of the voltage spread at check points throughout your system.

Permanent Installations of Sangamo Lincoln Thermal Voltmeters give you these benefits:

- *Continuous record of voltage conditions*
- *Indication of only "steady state" voltage variations for ease in setting voltage regulators*
- *Economical socket installation*
- *Simple reading—quick resetting*
- *Reduction of expensive service calls*
- *Elimination of costly periodic surveys*

Ask your Sangamo Representative, or write us for full information on Sangamo Lincoln Thermal Voltmeters and other Sangamo equipment for system betterment.

BILL OF MATERIAL

1—V2S* Thermal Voltmeter . $30.74

1—Standard Meter Socket . . . 2.92

*Used where outages are not a problem.

1—V3S† Thermal Voltmeter . $42.34

†Minimum reading not affected by outages.

SM58-A

SANGAMO ELECTRIC COMPANY *Springfield, Ill.*

FROM TOP TO BOTTOM, INSIDE AND OUT

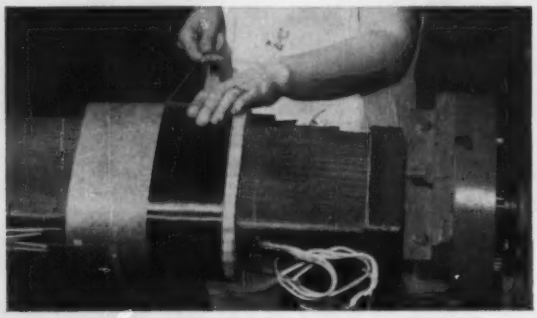
CENTRAL

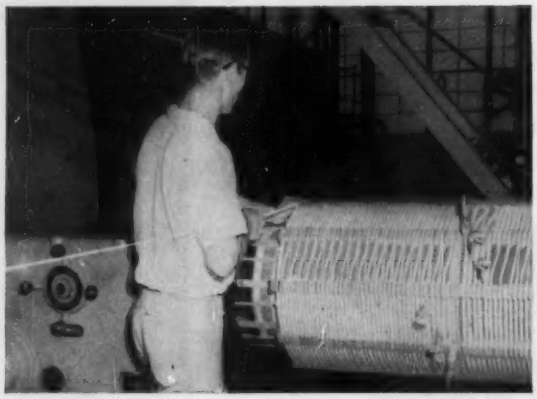
TRANSFORMERS

ARE BUILT BY EXPERTS

Every step of the way!

CTC





Highly Skilled, Experienced Craftsmen Work as a Team to Produce a Superior Product

For instance, let's visit Central's coil-winding department. Here you will find specially-trained workers with years of experience in the fine art of coil-winding. These workers recognize that the coil is the very heart of a transformer. They understand the vital importance of correct tension to insure that insulation is uniformly smooth and even. They take pride in their handiwork . . . with the result that the "heart" of every Central Transformer is as perfectly made as skilled human hands, using fine materials and modern machinery, can make it.

Just one more reason why Central Transformers are PREFERRED!

WE DESIGN AND MANUFACTURE QUALITY TRANSFORMERS —NOTHING ELSE

Central

TRANSFORMER CORPORATION

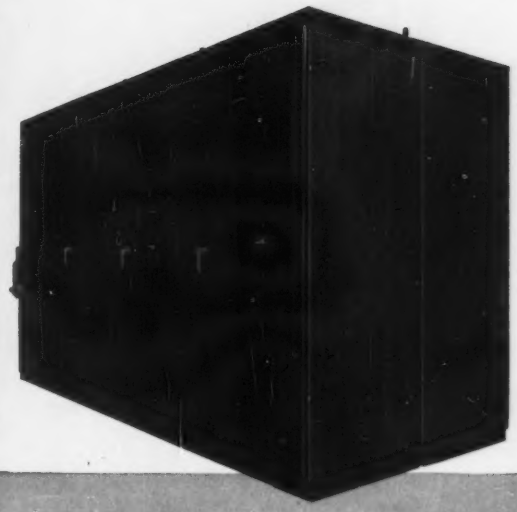
PINE BLUFF, ARKANSAS

Telephone JEfferson 4-5332

NEMA

Sales Offices in Principal Cities

for high voltage service continuity on your critical loads at lower capital outlay— it's S&C Metalclad Switchgear!

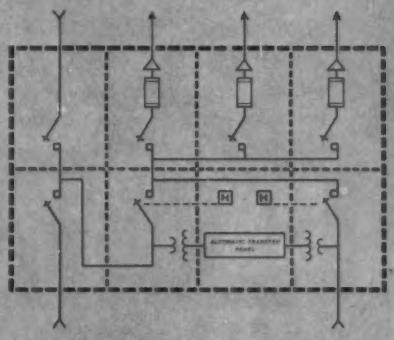


To get service continuity on critical loads, you need preferred-to-emergency switching of your alternate incoming high-voltage supply circuits, and short-circuit protection and switching on your outgoing high-voltage supply feeders. All of this can be provided in one low-cost package in S&C Metalclad Switchgear, as illustrated.

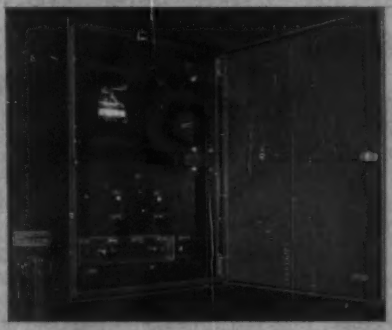
You even have built-in choices of throwover schemes through S&C's standard automatic transfer panels.

You save two ways:

1. You get metalclad switchgear with job-matched load interrupters and power fuses, in lieu of costly circuit breakers.
2. You eliminate cost of custom designing by using an off-the-shelf transfer panel with built-in options.



Schematic for 8-bay switching center unit (above) shows throwover control of 2 of 3 alternative incoming sources to provide continuous service for three outgoing feeders.

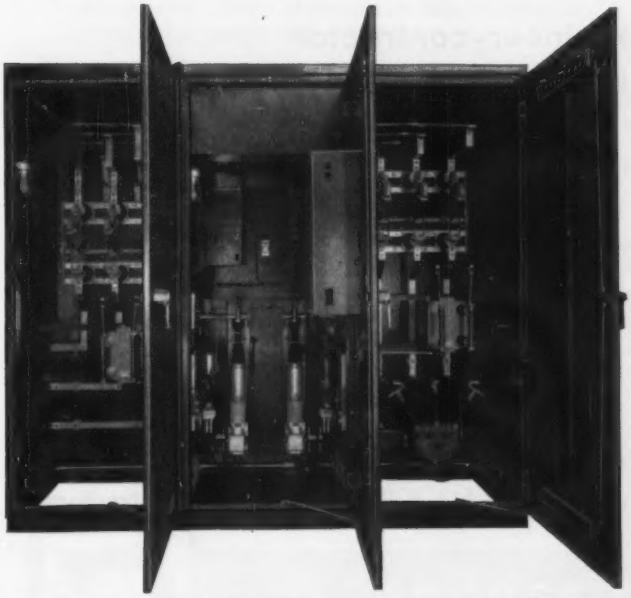


S&C Standard Automatic Transfer Panel provides for making either source preferred, for automatic or manual return, for adjustable time delays, for choice of returning in either open or closed transition, and for optional lockout on bus faults.

No organic insulation to cause corona trouble; porcelain and air only.

High-Speed Automatic Switching.

Full-length bulkhead doors; rainproof, with complete access.



Super Durabake finish with galvanized and stainless steel hardware; withstands corrosive atmospheres.

Separate compartment for Moto-Draulic operators; free access and decoupling for checkout.

Strip heaters with adequate venting prevents moisture accumulation.

Power Fuses
Tool Operated Disconnects
Open and Enclosed Cutouts
Fuse Links
"Loadbuster"
Load Interrupters
Metalclad Switchgear

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4421 Ravenswood Ave., Chicago 40, Ill.

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8 Vansco Road, Toronto 14, Ontario

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call KE for plant expansion or new facilities

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Our most treasured ingredient at Kaiser Engineers is ingenuity. It manifests itself constantly in new, more efficient, and tested ways of designing and building our clients' plants.

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Square D Vertical Action Magnetic Starters Sizes 0, 1, 2, 3, 4 and 5

ONLY SQUARE D GIVES YOU ALL 5

1 *QUICK* INSTALLATION!

No groping or fumbling. Square D gives you lots of wiring space, plenty of knockouts, handy and clearly marked pressure wire connectors.

2 *TOP* PERFORMANCE!

No needless downtime from coil burnout, mechanical binding, contact freezing. Square D gives you an extra-capacity magnet with a tough and cool-operating encapsulated coil to handle additional poles and interlocks—a guided single moving part—big silver cadmium-oxide contacts with strong finger springs—arcing yokes on larger sizes.

3 *REAL* OVERLOAD PROTECTION!

No change in trip characteristics because of mismatched parts supplied separately for field assembly, no distortion of heater in installation. Square D gives you melting alloy unit construction—factory-assembled and individually tested for bull's-eye accuracy. Also bi-metal and magnetic designs for automatic reset or adjustable trip applications.

4 *EASY* INSPECTION and MAINTENANCE!

No starter is "maintenance-free." But Square D makes the job easy. Inspection is a breeze. You don't have to remove wiring for contact replacement or take the starter out of the enclosure to change coils.

5 *WIDE-RANGE* ADAPTABILITY!

No need for excessive inventories to avoid costly waiting for non-standard arrangements. Square D provides "off-the-shelf" kits for changing contacts and coils, adding pushbuttons, selector switches, and up to 4 double-throw auxiliary circuits.

Send for the COMPLETE Story!

Square D Company, Dept. 21,
4041 North Richards Street, Milwaukee 12, Wisconsin

Please send me your new bulletin with detailed proof that Square D offers me my best starter investment.

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Company_____

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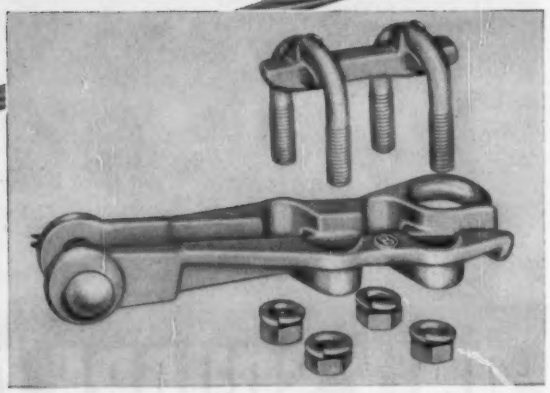
SQUARE D COMPANY

"Deadends Go Up



O-B Strateline features captive keeper piece, has long thread sections on U-bolts. Six sizes cover conductor range of .15 to 1.55 inches in diameter.

Fast When We Use O-B Stratelines"

STREAMLINED DESIGN, CAPTIVE KEEPER PIECE INCREASE EFFICIENCY, MAKE LINEMAN'S LIFE EASIER

Want to get away from fumbling with loose parts? Are you interested in reduced line losses, and in a clamp that can be readily worked "hot" or "cold"?

Then the O-B aluminum Strateline Clamp is your answer. Made by the company that pioneered this streamlined design, the Strateline comes in six sizes, can be used on conductors ranging from .15 to 1.55 inches in diameter. The three smaller sizes overlap in conductor range, so that you can select the most economical clamp for your series of conductors. All sizes have the captive keeper piece. Long thread sections on U-Bolts permit the clamp to be loosened enough to insert the conductor without taking the nuts off.

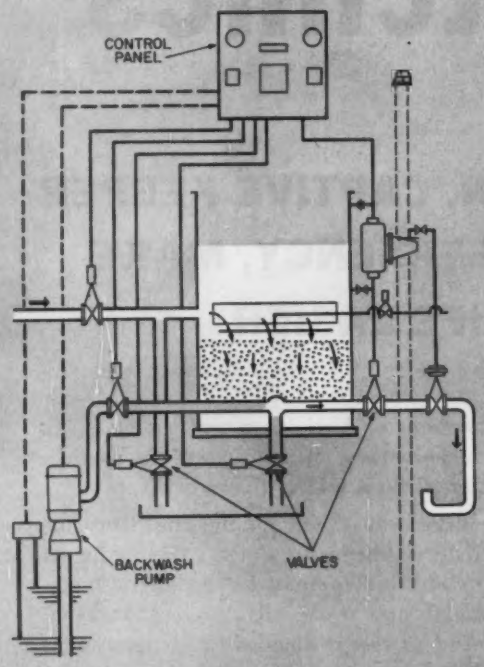
Because it's aluminum, the Strateline reduces line losses, quickly paying for its extra cost (compared to magnetic materials) and eventually paying for itself. And because it's made by a company that knows both insulator and hardware problems, you can be sure it's built to perform effectively in your distribution system.

OHIO BRASS COMPANY, MANSFIELD, OHIO
Canadian Ohio Brass Co., Ltd., Niagara Falls, Ont.

4839-H

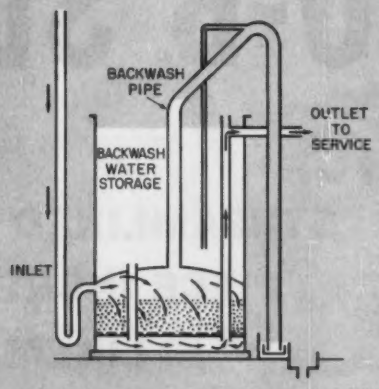
CONVENTIONAL gravity filter and hydraulic controls for automatic operation. Approximate installed cost of a unit that will filter 500,000 gallons per day:

$21,700.00



NEW PERMUTIT VALVELESS Gravity Filter. Completely automatic operation. Approximate installed cost of a 500,000 gpd unit:

$11,900.00



HOW IT WORKS: As dirt collects on the sand, increased head pressure slowly raises the water level in the large backwash pipe. See diagram. When it spills into the downward section of the pipe, it starts a siphon (backwash) flow that draws water down from the Storage area and up through the sand, "floating" dirt off to waste. When backwash water is gone, air enters the small tube and stops the siphon. Flow through the sand reverses and the first filtered water (rinse water) goes to Storage area until full. All flow then runs to Service.

New Valveless Water Filter Saves $$ for Industries, Cities, Electric Companies

• Big water users like city water departments, steam stations, refineries, chemical plants and paper mills can substantially reduce the cost of their water-conditioning equipment and its operation and maintenance . . . by adopting a new automatic Valveless Filter developed by engineers of the Permutit Company (N. Y.).

The simplified design makes ingenious use of the siphon and other hydraulic principles to replace expensive valves, flow controllers, pumps and hydraulic or pneumatic control systems. The design also prevents wasteful, excessive use of water for backwashing or rinsing. Tanks are shipped set-up to reduce installation costs. The absence of moving parts virtually eliminates maintenance costs.

The Valveless Filter produces uniform, high-quality water. It cannot be "forced." Backwashing or rinsing cannot be too little or too late . . . or accidentally run to Service. And the filter cannot develop common troubles like "cracked" or "upset" beds, "channeling" or "mudballs."

Single Valveless Filters or multiple units for any volume requirement are available. Present installations include units for industrial plants treating water for both process and drinking.

Send for free descriptive bulletin. Address: The Permutit Company, Dept. EW-5, 330 West 42nd St., New York 36, N. Y. or The Permutit Company of Canada, Ltd., Toronto 1, Ontario.

PERMUTIT®

rhymes with "compute it"

A DIVISION OF PFAUDLER PERMUTIT INC.

Water Conditioning

Ion Exchange • Industrial Water Treatment

DUAL VOLTAGE transformers

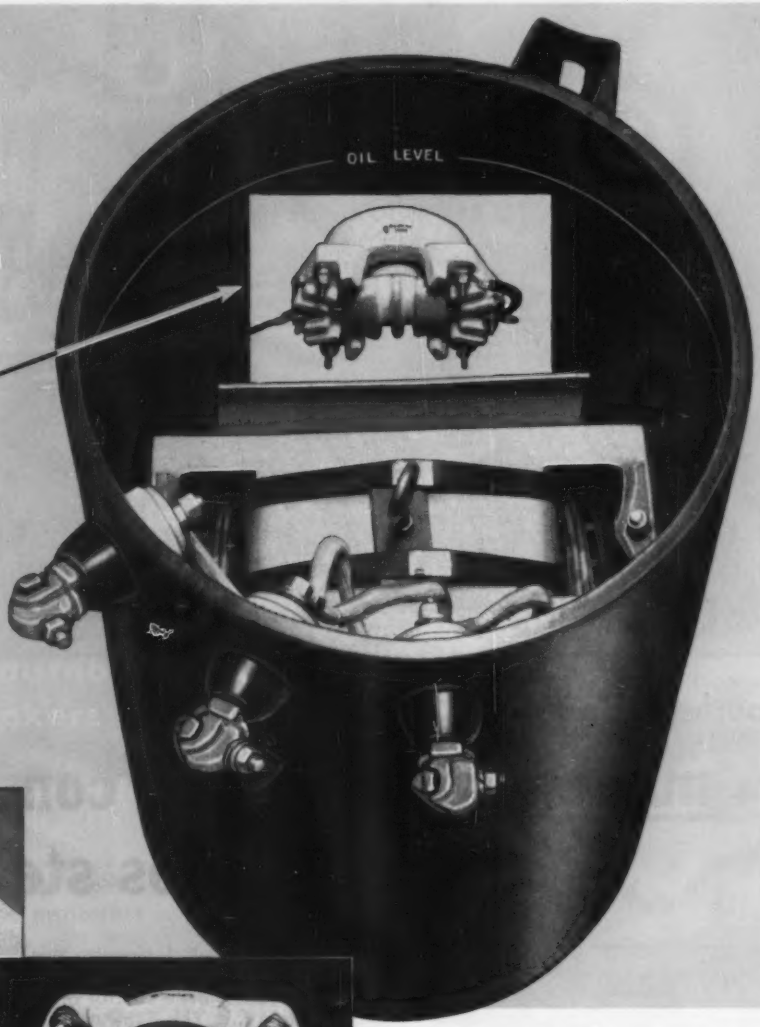
MEAN SAVINGS IN MONEY, TIME, LABOR

You save in stocking requirements . . . one unit can be stocked where it now takes two.

You save transformers from obsolescence when system voltage is increased.

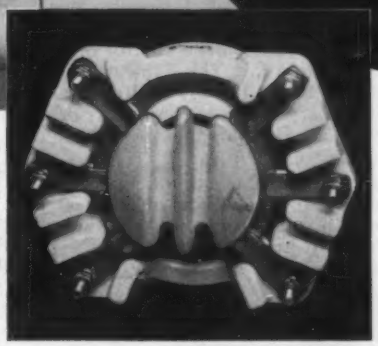
You save on change-over, cutting both down time and labor time.

Voltage change-over switch is mounted on the inside of the tank, under the oil level. It is fully operable from outside the tank.



Switch is sealed and protected from damage by removable screw cap and neoprene gasket.

Simple operation! Remove screw cap and reverse, using cap as handle for rotating switch.



Switch is rotary-bridging-to-position type, with both positions clearly identified by a stamped plate on the switch. Body constructed of wet process electrical porcelain with ample creepage. Fully impulse tested by NEMA standards.

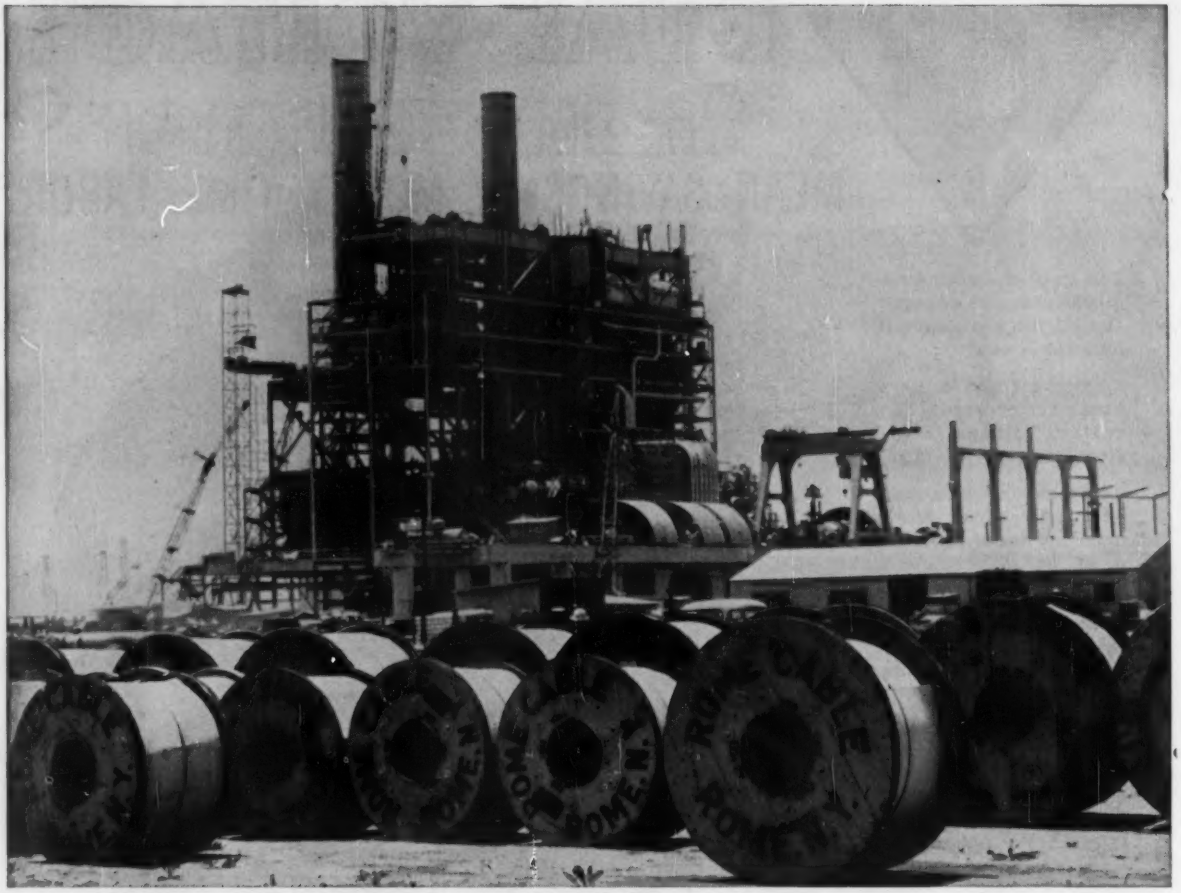
For positive protection against puncture, flashover, or lightning failure the entire transformer is always insulated for the basic insulation level of the highest name plate voltage.

Available in	**2400 x 4800 volt** **2400 x 7200 volt** **4800 x 14,400 volt** **7200 x 14,400 volt**	**from 10 through 100 KVA.**

Like all RTE Transformers, dual voltage models are backed by a five year guarantee. They are available from conveniently located warehouses throughout the U.S.

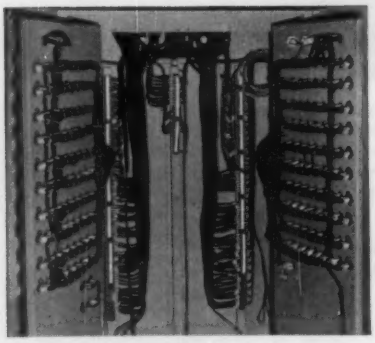
RT&E CORPORATION
WAUKESHA, WISCONSIN

HELPING PROVIDE POWER FOR AMERICA



Southern California Edison installed . . .

¼ million feet of Rome control cable in the Alamitos steam station



EASY TO HANDLE, STRIP, SPLICE. The clean, low-friction surface of Rome's control cables enabled Alamitos workmen to pull the cable through conduits and into this cabinet quickly and easily.

For its station control circuits, this large West Coast utility selected high-quality Rozone-Roprene control cable —*253,000* feet of it. This Rome cable is a logical choice for any such permanent installation since it represents the ultimate in control cable design and performance.

Built to last. Each conductor is insulated with a premium-quality, oil-base insulating compound—Rozone—which provides excellent protection against corona and ozone cutting. Rozone is also highly resistant to water and aging. Each individual conductor is then covered with a tight-fitting color-coded Roprene (neoprene) sheath.

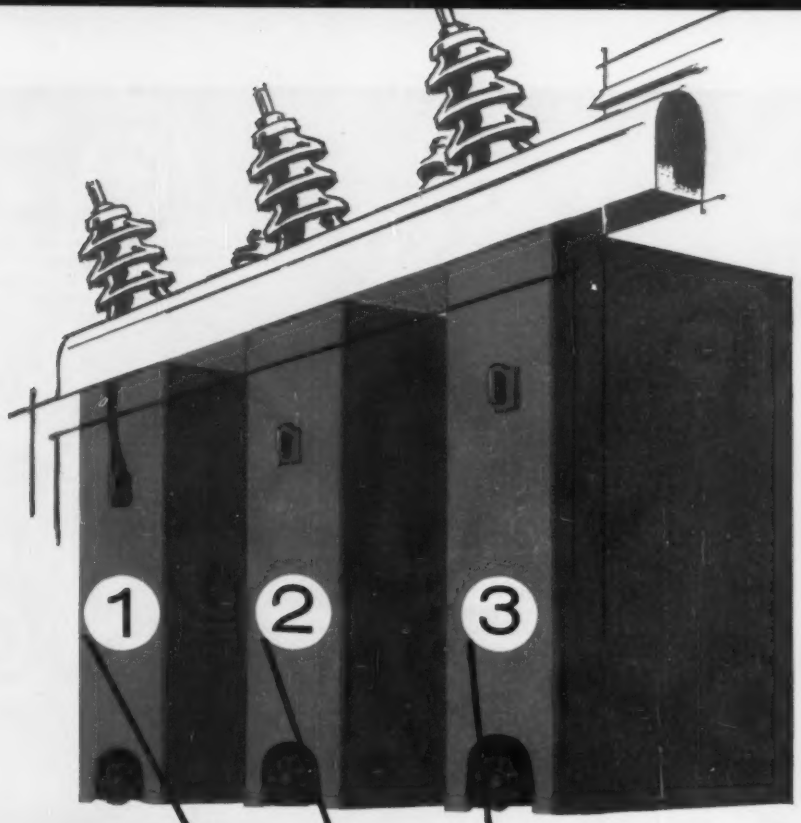
Over-all protection is provided by a Roprene jacket, which not only resists weather, oils, chemicals, and even flame, but also provides a high resistance to mechanical injury during and after installation. And this tough Rome Cable material is virtually immune to corrosion and electrolysis.

If you want the very best in station control cable for your next job, specify Rozone-Roprene. Contact your nearest Rome Cable representative for more information—or write to Department 803, Rome Cable Corporation, Rome, New York.

ROME CABLE

CORPORATION

3 tanks are better than 1



for positive protection with outdoor distribution breakers

Ratings:
14.4 and 23 kv,
100 and 250 mva

Just like big breakers, there are 3 tanks for complete phase isolation. This means positive protection against internal phase-to-phase flashover.

Extra protection is only one of the many benefits you obtain in 3-tank design. Maintenance is easier; tanks are smaller and easier to handle; and oil contamination is reduced.

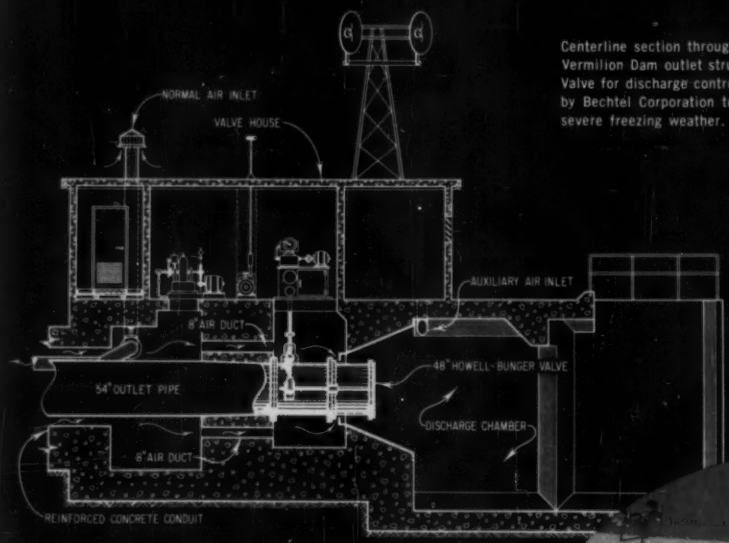
There is no extra cost for this 3-tank breaker with big-breaker features.

For the complete story ask for Bulletin 71B7946. Call your nearby A-C office or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-5622



Centerline section through Southern California Edison Company's Vermilion Dam outlet structure shows 48-inch SMS Howell-Bunger Valve for discharge control. It is mounted in a chamber designed by Bechtel Corporation to minimize spray, erosion, and icing in severe freezing weather.

Valve discharging approximately 800 cfs at full gate has caused no noticeable erosion to channel in three years operation. Southern California Edison Company's Vermilion Dam and reservoir is on Mono Creek in the Sierra Nevada of California. At the Company's Portal Powerhouse on Huntington Lake, Calif., a 90-inch SMS Howell-Bunger Valve also operates under severe winter conditions by remote control.

Remote Controlled SMS Howell-Bunger Valve at Vermilion Dam Provides ***EASY REGULATION OF FREE DISCHARGE***

A 48-inch SMS Howell-Bunger Valve was chosen for Vermilion Dam to provide close, accurate regulation of releases from 10 cfs to 700 cfs. Remote control was necessary because of the isolated location of the site, and dependable operation and minimum maintenance were required, even in 20° below zero winter weather. Since late in 1954, this Howell-Bunger Valve has operated successfully under all conditions.

Rugged, simply designed and low in initial cost, the SMS Howell-Bunger Valve gives you:

- Free discharge with safe energy dissipation.
- Hydraulic balance without vibration.
- High coefficient of discharge for an energy dissipating valve.
- Minimum cavitation and maintenance.
- Simplicity of operation.
- Only one moving part in contact with stream.
- Discharge into atmosphere or under submerged conditions.

To obtain complete information, write to S. Morgan Smith Company, York, Pennsylvania.

S. MORGAN SMITH HYDRODYNAMICS More Power To . . .

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED, TORONTO

Rotovalves • Ball Valves • R-S Butterfly Valves • Free-Discharge Valves • Liquid Heaters • Pumps • Hydraulic Turbines & Accessories

YOU GET

LONG-LASTING PROTECTION FOR YOUR OVERHEAD SYSTEM

with

BLACKBURN *Grounding* DEVICES

Type GTC 1
One plate tower ground clamp

Type GTC 2
Two plate tower ground clamp

Copper Bonded Pigtail

Type GUV
U-bolt ground clamp parallel or 90°

Steel Driving Stud for Sectional Ground Rods

Type GG
Ground Rod Clamp
Socket set screw

Copper Alloy Coupling for Sectional Ground Rods

Copper Bonded Sectional Ground Rods

Copper Bonded Regular Ground Rods

Type GGH
Ground Rod Clamp
Square head bolt

Type B
Budget Line Ground Rod Clamp
Square head bolt

Type GP 100
Electrolytic Copper Pole Bottom Plates
7½", 10", 14" dia.

Blackburn grounding devices will save you thousands of dollars annually in preventing burnouts of expensive overhead equipment. This complete line simplifies your stocking problem—one source for all your needs. Like all BLACKBURN products they are constructed of high-strength corrosion resistant materials—designed for easy installation and engineered for long-lasting, trouble-free grounding. Always specify BLACKBURN.

Available Through Electrical Wholesalers Everywhere

DISTRIBUTED ON THE WEST COAST BY

KORTICK MFG. CO.

JASPER BLACKBURN CORPORATION

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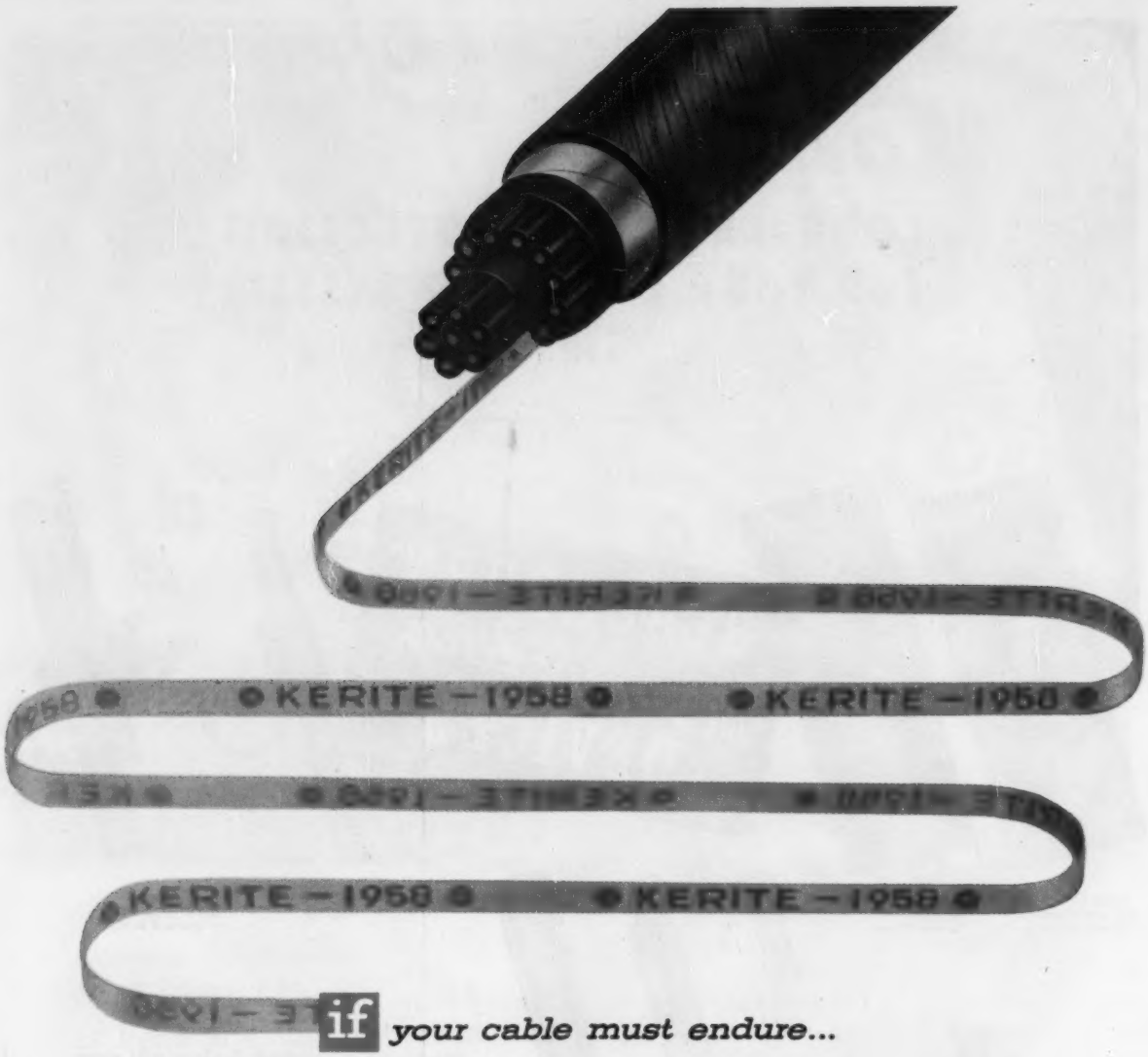


if *your cable must endure...*

—turn to Kerite with assurance. For Kerite's wide range of quality insulated cables are unrivaled for *on-the-job* dependability and economy under all types of operating conditions.

In actual use, Kerite cables have been examined, salvaged, and returned to stock after as many as 50 years of continual service.

So we think that we may properly say: when quality and long life are essential . . . you can rely on Kerite.

Our headquarters office is at 30 Church Street, New York 7, N. Y. Branches are in Ardmore, Pa., Boston, Cleveland, Chicago, Houston, San Francisco, St. Louis, Glendale, Cal.

KERITE CABLE

it's the **KERITE** *that makes the difference*

Editorial Comment

MAY 26, 1958

More Research Needed At Higher Voltages

In a recent editorial we commented that the United States has come to be known more for the exploitation of advances in science and engineering than for contributions to them. The inference is clear that the aim of science in America today should be directed not only to perfecting and improving what we already know how to do, but to prove the feasibility of new ideas and techniques.

Elsewhere in the world today new approaches to the problems of bulk transmission of power at high voltage are being tried. Early this month the Russians began building a 310-mile, 800-kv dc transmission line. Two months ago in England contracts were let for terminals of a 200-kv dc submarine cable under the English channel. In France development of a 500 kv ac cable is reported.

This is not to say that we have been idle in the United States. To the contrary, transmission research at 345 kv is going forward in Colorado on corona and radio interference performance of overhead lines at high altitude. A contract is being drawn for a $500,000 extra high voltage cable testing program at Cornell University. Moreover, at least one utility organization is experimenting with problems of dc transmission.

This is a significant beginning. But the need for much more research in extra high voltage transmission is already in sight. A substantial body of engineering opinion today already foresees the prospect of an upward step in transmission voltages to 460 kv in ten years and perhaps to 650 Kv somewhat later. Two organizations in this country are already investigating possibilities of 460 kv.

Prospects of such steps even in 10 years, accentuates the many areas where new approaches and new knowledge of extra high voltage phenomena is urgently needed. These include the areas of lightning surge performance of EHV lines, switching surges in relation to the performance of apparatus with reduced BIL, detailed understanding of corona and radio interference, and vibration.

To investigate and solve these problems and to explore related gray areas in the field of dc transmission, extra high voltage cable and apparatus design will require research programs and expenditures far beyond anything the industry has yet undertaken in this field. It's now time to start thinking about where the money's coming from, how the programs are to be coordinated, and who is going to do it.

Let's Use the Rainy Days to Modernize

Although the present slowdown in industrial production is a legitimate source of concern both for American industries and for the utilities that serve them, it is also an opportunity that should not be wasted. In the past decade of enormous industrial growth, electrical distribution systems in many industrial plants have become outmoded as a result of the rapid increases in the amount of electric power used in production processes. To avoid costly stoppages in production runs, modernization and expansion of electrical facilities has been put off "til later."

"Later" is now here. With most industries operating below capacity, both time and manpower are available to bring in-plant distribution up to date. A great majority of informed observers agree that we are experiencing only a rainy season, not a Biblical deluge, and that sunny days will bring even greater use of electric power in industry as markets and the need to reduce costs increase even further. Taking a cue from the American farmer, industry can use its rainy days to get equipment in shape for the better ones. Such action would be both a testimonial of industry's faith in the future and a stimulus to the national economy.

AEC Ponders Site Choices, Indemnity Changes

Alternate A-plant site requirement under study; $3-million minimum on private insurance viewed as too high

The Atomic Energy Commission, spurred by congressional worries over possible nuclear accidents near large cities, is considering a requirement that would-be operators of power reactors prove they have picked the best practical site for proposed nuclear power stations.

Applicants of the future, as a result, may have to propose alternate sites in case one is turned down.

Some members of the Joint Committee on Atomic Energy, particularly Rep Chet Holifield (D-Calif.), are afraid a serious nuclear incident in a heavily populated area would set back atomic power development.

They repeated their fears at a recent hearing into safety and indemnity problems in the atomic field.

Holifield pointed out that in Sweden, for example, a proposed site must be approved before the rest of a reactor project is even considered. In the U.S., on the other hand, site selection is just one of many safety factors considered in the licensing process—and is pretty much a *fait accompli* when it reaches AEC for review. Disapproval would jeopardize substantial investments.

Harold L. Price, director of AEC's Division of Licensing and Regulation, says the commission does not wish "to pick the site for the applicant." But he agreed something more must be done to make sure the proposed site is proper from the public safety standpoint.

Price said criteria may be published under which applicants will be required to detail the risk to the public in any conceivable accident and to explain how the specified site was chosen. The advisability of requiring alternate site proposals is under study.

In testimony the same day on the government indemnity program, Price said industry comment will be invited soon on proposed amendments to temporary regulations issued last fall implementing the Price-Anderson indemnity law. A public hearing will be held.

The law offers companies building or operating nuclear facilities government indemnity up to $500-million against damage claims resulting from nuclear incidents. However, such firms must carry private insurance equal to $150 per thermal kw capacity—or a minimum of $250,000 for licensees operating small research reactors, and a maximum of $60 million for those operating reactors of 100,000 kw(e) or more.

A previous draft of proposed changes would have increased the minimum private insurance requirement to $3 million. And it laid out a formula under which financial protection required for larger reactors would be subject to adjustment on the basis of: **1.** The fuel cycle, or length of time fuel material is exposed in the reactor, and **2.** Population density in the surrounding area.

Price says conferences with insurance and industry representatives have led to the conclusion that the $3-million minimum insurance requirement is too high, while the existing $250,000 level is too low for some reactors to which it is applied.

As a result, the proposed amendment is expected to break small research reactors into several categories and specify the proper amount of financial protection for each.

Congressional Action Nears on Euratom

The U.S. government and Euratom—the six-nation European atomic energy agency—have agreed in principle on a program of cooperation in building 1-million kw of nuclear power capacity in Europe over the next five years.

The initial 1-million kw will be the first slice of Euratom's longer range goal to install 15-million kw of atomic power capacity on the continent by 1967.

The Euratom Commission now is in the process of giving its final approval to the proposed joint effort. As soon as that is done the State Department and AEC will submit the program to the Joint Committee on Atomic Energy as the first step in obtaining congressional approval of U.S. participation. The Administration expects to be ready to go to Congress by the end of the month and is hoping that Congress will act on the program before the end of this session. U.S. officials fear that if action is delayed the whole program might bog down.

The initial program calls for installation by 1963 of six or seven large nuclear power plants within the territory of the agency's member countries—France, Western Germany, Italy, Belgium, Holland, and Luxemburg. Total cost of the program will be approximately $350-million for the plants, including the reactors, and another $100-million or so for enriched fuel to be procured in the U.S.

Under the draft agreement the U.S. government would finance purchase in this country of roughly $130-million worth of boiling water and pressurized water reactors. It also would finance purchase of about $100-million worth of enriched fuel—first large outright sale of fuel by the U.S. The U.S. would agree to buy back any plutonium, which the Europeans wish to sell, at a fuel price of $12 per gram. Present thinking calls for the U.S. financial contribution to be made by the Export Import Bank rather than a congressional appropriation.

The proposed program means sales of perhaps $500-million or more worth of American reactors and equipment over the next decade. More important, it will pave the way for lucrative licensing agreements in the future and give the U.S. power industry a chance to gain invaluable experience in large scale nuclear power operations.

Tucson unit sets generating milestone as . . .

Private Utility Capacity Hits 100,000 Mw

When Tucson Gas, Electric Light & Power Co began spinning a 75,000-kw unit at Plant No. 4 on May 11, the utility gained the distinction of boosting generating capacity of U. S. power companies to the 100-million kw mark.

Edison Electric Institute, in announcing the milestone, said a record total of almost 16-million kw of new capacity will go on the line this year for both investor-owned and governmental electric utilities.

The industry's total generating capacity hit 130,356,000 kw on March 31, about twice the output figure at the end of 1950, EEI said.

Capital spending of "some $4 billion . . . by electric companies for new plant and equipment" is scheduled for 1958, said J. W. McAfee, president of EEI and Union Electric Co. About 50% of the expenditure is allocated to new generating capacity. Power company investment in electric plant and property totaled about $36.5 billion at the end of last year, McAfee said. This is almost double the 1950 total.

The Urge to Merge Grows

A study is underway for a possible merger of Iowa Power & Light Co and Iowa-Illinois Gas & Electric Co. The proposed consolidation would "effect savings which should at least partially offset the continuing upward trend in the costs of just about everything required to build and operate . . ." a joint announcement said. Operating headquarters of Iowa-Illinois would be retained in Davenport. Important staff functions of the merged companies would also be centered in the Quad-Cities and a general headquarters in Des Moines. The merger, subject to stockholder and regulatory authority approval, would not be completed before the end of '58. The two utilities serve about 270,000 electric and 206,000 gas customers. Both systems are interconnected. Stone & Webster is conducting the study.

Wyoming Public Service Commission has approved an exchange of securities which paves the way for merger of Southern Utah Power Co into California Pacific Utilities Co. California Pacific serves Cakeville, Wyo., and the surrounding rural area.

Duke Power Co has received Federal Power Commission permission to buy the distribution system serving 800 customers and the transmission line of Carolina Mountain Power Corp.

Interstate Hails a Safe Year

The 1,200 employees of Interstate Power Co racked up a perfect safety year last fortnight. They worked 2,300,000 manhours without a disabling injury, a record on which "management is happy to acknowledge the accomplishments of our employees," said Pres M. L. Kapp.

A-Plant Cost Sharing Studied

The Joint Committee on Atomic Energy is studying a tentative arrangement under which the Atomic Energy Commission will contribute some $14.6-million toward the cost of a demonstration nuclear power plant at Parr Shoals, 25 miles north of Columbia, S. C.

The committee has 45 days within which to exercise its power to veto the prospective agreement with the Carolinas Virginia Nuclear Power Associates.

Target date for completion is June 30, 1962.

The agreement would cover design, development, fabrication, construction, and test operation of a heavy water-cooled, heavy water-moderated pressure tube type reactor fueled with slightly enriched uranium. Net electrical capacity would be 17,000 kw.

The associated power firms will pay the capital costs, estimated at some $22-million. AEC contributions would include cost of research and development programs and the value of fuel use charges which would be waived for the first five years of plant operation.

The agreement, coming at this time, may take some steam out of a proposal by committee Democrats that the U. S. build a heavy water reactor burning natural uranium.

Westinghouse Electric Corp would furnish pre-operation research and development, and design and manufacture the proposed plant.

COOKE: Demand was there

The Job Ahead for REA: I. Flourishing Early Years

Stormy beginning put power companies on the defensive. Anti-depression loans were viewed as impractical, farmers lacked cash to buy wiring, and federal projects got underway

This month hundreds of rural radio and TV stations are carrying Agriculture Department news programs, announcing proudly that the Rural Electrification Administration is now 23 years old. ABC's "American Farmer Hour" and NBC's "Farm and Home Hour" also have followed suit.

Among REA's achievements, the programs point out, are completion of a loan to finance connection of the 5-millionth customer to REA lines and an approaching loan to connect the millionth 'phone subscriber.

REA also has tied its recent campaign for expanded appliance loans to its 23rd anniversary. This campaign, urged by President Eisenhower, aims to increase appliance, equipment, and wiring purchases by rural consumers through loans by REA to its borrowers.

Although born in 1935 as a New Deal anti-depression project, REA's creation followed a decade of agitation by federal power advocates, conservationists, and social reformers. From the outset, it has been the football of the federal vs private power fight.

REA promoters included such early federal power advocates as Sen George Norris of Nebraska, President Franklin D. Roosevelt, and Chairman Morris L. Cooke of the "Mississippi Valley Committee"—A group of technicians set up to study farm electrification feasibility. Cooke's group reported in 1934 that federal leadership was necessary to get central station power to sparsely-settled farm areas.

Back in 1923, the National Electric Light Association—forerunner of Edison Electric Institute—had formed a committee on electricity's relation to agriculture. It set up model farms near Red Wing, Minn., pointing up a market potential. In 1925, Cooke directed for Pennsylvania Gov Gifford Pinchot a survey which supported those who said there was a strong demand for farm power.

The Tennessee Valley Authority was established in 1933 and the following year the Alcorn County Electric Power Association, with no federal financing, began supplying TVA-generated power to customers over nearly 100 miles of line in and around Corinth, Miss.

The Emergency Relief Appropriation Act of 1935 provided the opportunity for a federal program, and on May 11 of that year Roosevelt authorized $100 million for rural electrification. REA was established as a part of the Federal Emergency Relief Administration; Cooke was the first administrator.

Difficulties developed immediately. Skilled workers needed to construct the rural systems could not be found on relief rolls, as specified under the emergency act, and the act's grants-in-aid provisions were not suitable to REA's needs.

Loan Rules Blocked Companies

A committee of 15 major power companies reported to Cooke, shortly after the emergency funds became available, that rural electrification would be economically unfeasible for private utilities unless $125-million in federal credit could be advanced to prospective rural customers for buying appliances, wiring, and service connections. They held that the REA loan regulations were not practical for private development of rural systems, and that considerable time would be needed to adjust existing rate schedules.

In addition, some power companies were unwilling to make large capital outlays for rural electrification while the government was developing TVA and Congress was about to pass the Wheeler-Rayburn bill to divorce holding companies from their operating utilities. When passage of the holding company bill became imminent, Wendell L. Wilkie, board chairman of Commonwealth & Southern, said "Utility properties cannot be expanded, rates cannot be reduced, capital expenditures cannot be made against the calamities of the threatened invasion

Number of REA Borrowers and Connected Consumers Level Off

Calendar Year	Total No. Borrowers	Energized Lines (Mi)	Consumers Connected	Annual Loans (Fiscal Yrs)
1936	29	3,000	7,508	$13,903,412
1940	685	267,846	674,495	41,736,000
1944	826	410,471	1,216,798	31,930,124
1948	952	759,494	2,518,450	313,023,099
1952	1,020	1,244,645	3,858,396	165,425,811
1955	1,026	1,351,210	4,251,250	164,187,315
1956	1,026	1,382,737	4,361,896	188,131,345
1957	1,030	1,405,089	4,466,709	298,704,669

of a business by the federal government."

Cooke then began encouraging rural co-ops to organize and borrow funds from REA.

On May 20, 1936 REA became an independent agency getting its appropriations direct from Congress and with regulations giving preference for loans to co-ops. Under this REA Act, electrification loans were to be made over a 10-year period with a 25-year life at 3% interest. A year later the interest rate was put on a sliding scale varying between 2.88 and 2.48%. The present 2% rate was not set until 1944.

Loans were authorized to furnish power to rural areas not receiving central station service. "Rural areas" were defined as those outside the limits of towns larger than 1,500; this is still the definition in the law. The act authorized loans to connect both farm and non-farm consumers in these areas; it still does.

Farmers Outnumbered 2-to-1

Area coverage, including industrial consumption, was permitted, but in 1936 there was little thought that rural systems would serve other than farms and rural homes. In rural areas, as defined in the law, farmers outnumbered the non-farm population 7-to-5; in today's "rural" population farmers are outnumbered about 2-to-1. Only 10.9% of the farms had central service, and Congress heard predictions that electricity never need be supplied to more than 35%.

In 1937, Cooke retired and was replaced by his chief engineer, John M. Carmody. During Carmody's tenure, REA and private companies worked out the difficult task of finding wholesale rates which the rural systems could afford and would fit into utilities' existing rate schedules. The co-ops began to flourish, and the rural power market mushroomed (see table).

Next week's issue explores the sometimes rocky road of REA through the war years, the formation of the National Rural Electric Cooperative Association under Clyde T. Ellis, and changes taking place in co-ops' sources of power.

Indian Slow Down ▸ Ends at Niagara

The Tuscarora Indian woman and her 749 tribe members finally gave up a war of passive resistance earlier this month. Their efforts to halt surveys for a Niagara hydro reservoir are now taking the form of a federal court fight to see if the New York State Power Authority can appropriate part of the reservation, which the Indians claim is protected by federal treaties.

If the court action holds up construction, the delay will cost the authority some $100,000 a day. Users of steam power in the area will absorb a comparable loss.

Indiana Service Ban, Kansas Accord, Wyoming Tax Draw Industry Interest

An investigation in Indiana, accord in Kansas, and a Wyoming tax ruling are the highlights of recent developments affecting rural electric cooperatives and municipal systems.

Residents of two Indiana counties instigated a petition to investigate whether it's constitutional for utility co-ops to refuse service unless residents become stockholders.

The petition was filed with the state Public Service Commission by George L. Diven, public counseler. The action is aimed specifically at the Pulaski-White Rural Telephone Co-op of Star City, but Diven said it would affect the practice of rural electric co-ops also.

A 1951 Indiana law provides that no one can be a stockholder or member of a co-op unless he also uses the services. This has been given a reverse twist, Diven said, so that to get service now, a customer must join.

A. D. Mueller, Indiana Statewide Rural Electric Co-op manager, said the telephone case would not affect the 43 electric membership corporations in the state. Diven countered that if compulsory membership for 'phone co-ops is outlawed, electric co-op members would likewise be entitled to their freedom.

In Kansas a lengthy controversy about serving outlying industrial load has been tempered by new rules and regulations issued by the State Corporation Commission.

Under the new rules the electric utility with service lines closest to the prospective customer will be the one permitted to serve, providing service capability is adequate.

The KCC rules, unanimously endorsed by both co-ops and companies, also provide that:

- A utility will not build in its certified area a line to serve a customer already served by another utility without written permission of the other utility, unless the KCC finds service is inadequate.
- No utility shall provide service to a city served by another utility. In cases where a city's boundaries are extended to include electric properties owned by another utility, the one franchised by the city may buy the properties of the fringe area utility.

Wyoming's District Judge Allen Pearson has ruled that the State Board of Equalization is legally in the clear to tax 12 municipally-owned electric systems.

The judge upheld the board's view that city owned utilities are a proprietary function, rather than a governmental operation. The municipalities are appealing the finding to the State Supreme Court.

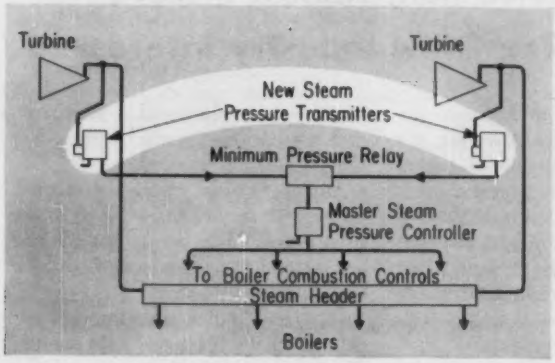
Here Is a Way to Reduce 480-V

T. B. TUCKER, Meter Department, Central Power & Light Co, Corpus Christi, Tex.

A new metering installation, developed by Central Power & Light Co, has reduced costs of metering at 480 v and higher. The design, made possible by the new butyl-molded, outdoor-type potential transformer, is for outdoor-type, 3-wire, 3-phase, 480-v transformer-type metering.

For safety reasons, Central Power & Light has used potential transformers on meters of the 480-v class and above. With indoor-type transformers it was necessary to enclose the transformers in a steel box at the pole top.

However, the butyl-molded outdoor-type potential transformers can be mounted on a steel plate along with the outdoor donut-type current transformers. This design eliminates the steel box and a terminal block, as well as the labor involved in connecting the transformers to the terminal block.



New Controls Boost

Pressure control equipment installed recently at the throttles of two turbines has made it possible to change operation from 850 psi at the steam header to 850 psi at the turbine throttles at all times.

This change at Central Illinois Public Service Co's Meredosia Plant increased the capability of the two machines from 133 to 136 Mw and improved the station heat rate. This was accomplished at nominal cost by adding control equipment without exceeding design pressure or temperature of the boilers or turbines.

Easy Way to Replace Wicket-Gate Shear Pin

The shear pin in a wicket-gate operating mechanism can now be replaced safely by one man in five minutes. A new technique, developed at Tennessee Valley Authority's Hales Bar Hydro Plant, employs a special tool which permits replacing the pin without removing the unit from service or altering the design of the gate arm. Formerly repairs required 3 hours and a shutdown.

When a shear pin breaks, water pressure immediately forces the wicket gate to the full-open position against a mechanical stop. This stop is 1 in. beyond the 100% gate opening.

With the new procedure the wicket gate is brought to 100% gate opening, and a device is installed to lock mechanically the wicket-gate arm to the gate control link. The device consists of a steel bar with a hole drilled at one end and a pin welded to the other. This pin is inserted in the hole in the gate control link, and a standard shear pin is run through the hole in the device and into the hole in the wicket gate arm.

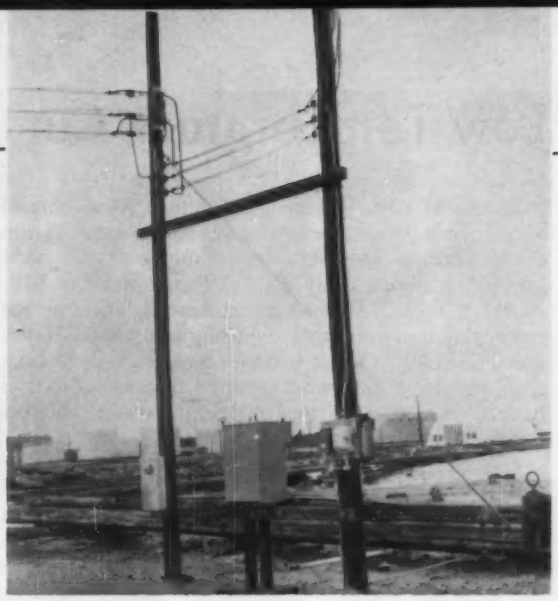
Installation of the device permits positioning the gate by its normal operating means to approximately its 90% opening. This pulls the wicket gate arm back away from the mechanical stop 1 in., and a 1-in. wedge is placed between the stop and the arm to hold the gate in position.

Finally, the device is removed, the holes in the link and arm are aligned, and the new shear pin is installed. To complete the operation, the wedge is removed.

Previously, when a shear pin broke, the unit was removed from service and the head gates set in place; then the pin was replaced. This practice required a great deal of labor to manipulate the head gates, involved hazard to men jacking the gate closed, and caused a 3-hr shutdown.

Metering Costs

The installation employs the current transformers at each end of a 9 x 27-in. steel plate with the potential transformers between them. No terminal block is used in the secondary circuit. Connections are made directly to the transformer terminals from a neoprene-jacketed control cable which is stapled to the pole under wood molding and runs to the meter box below. The exposed connections are covered with a sealing compound to prevent corrosion otherwise encountered in contaminated atmospheres.

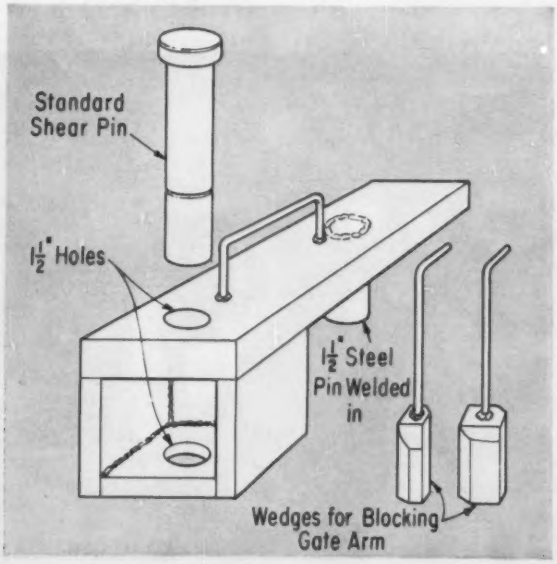


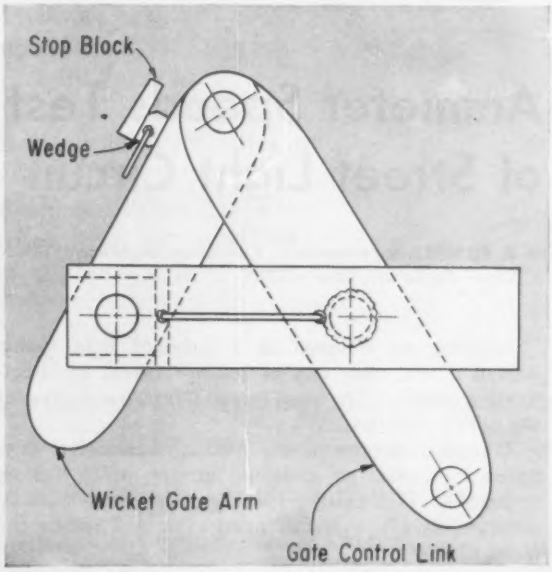
Plant Output

Formerly, steam pressure was controlled at the steam header. This resulted in a varying pressure at the throttles, depending on the amount of pressure drop in the steam lines from the header to the throttles. As loads rose, the increased steam flow resulted in larger pressure drops. Thus, pressure was lowest at the throttle when load was maximum, and machine capability was minimum when load was maximum.

The change in controls corrected this condition. A pressure transmitter was installed to measure pressure at the throttle of each turbine. The output from these transmitters is sent to a minimum pressure relay, and its output is transmitted to the boiler steam pressure controller. The boilers then adjust their rate of steam generation in response to the signal.

Generator capability is now 69 Mw when pressure at the throttle is maintained at 850 psi. Generator capability dropped to 67 Mw under the old control scheme when throttle pressure dropped from 850 psi at a load of 24 Mw to 832 psi at a load of 67 Mw.





Low Temperature Cuts Battery Output

Lead-acid batteries, conventionally used to control outdoor switchgear, are susceptible to a drastic drop in discharge capacity at low temperatures. At 0F their 1-min discharge is only 40% of rated value at 77F. At the same time, low temperatures may increase the power required to operate switching equipment. Hence it is important to select batteries large enough to meet requirements at the lowest expected ambient, or to heat battery compartments to a temperature that will sustain battery output.

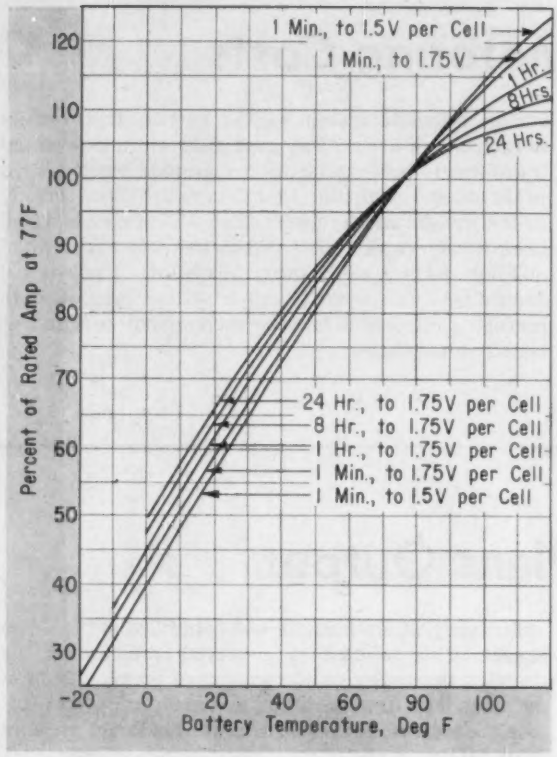
Effect of temperature varies with the discharge rate and, to some extent, with different types and sizes of cells. For practical purposes, the family of curves in the illustration may be considered as typical. Reproduced from a bulletin in preparation by Electric Storage Battery Co, they illustrate how ampere ratings should be corrected for various time periods.

These curves apply to a final voltage of 1.75 v per cell. For the 8-hr discharge rate, this value is a point on its volt-time curve where the voltage begins to fall rather rapidly. When a battery discharges at a higher rate, this "knee of the curve" is at an inherently lower voltage. For the 1-hr rate, it is 1.60 v per cell.

As ambient temperature drops, the possibility of freezing must be considered as well as loss of capacity. Slush ice begins to form in the electrolyte at these specific gravities and temperatures respectively: 1.200 and −16F; 1.175 and −4F; and 1.150 and +5F. However, charging current has a small heating effect, and no freezing has been reported with the floating-charge method used on switchgear applications.

Batteries could be produced to meet low-temperature conditions, but heating of the battery compartment or room, however, is recommended.

A battery room temperature in the 60-90F range bests suits the battery, the charger and personnel. Where such temperature averages over 90F for longer than 30 days and below 40F for only a few days, a full-charge gravity of 1.170 (1.160 to 1.180) affords longer battery life. For cells so applied the floating voltage is 2.12 v.

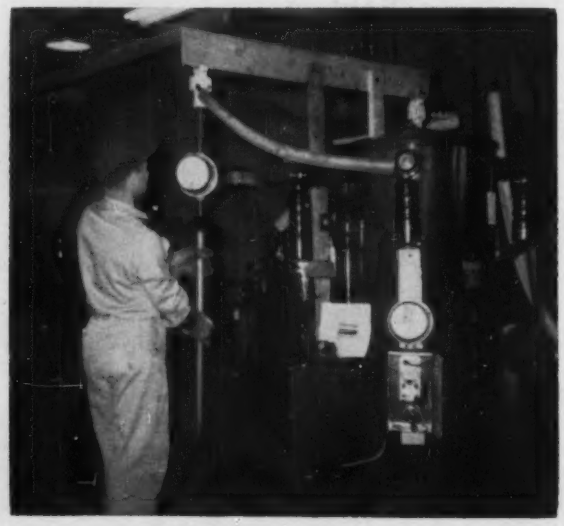


Ammeter Speeds Test of Street Light Circuit

G. R. ROBERTS, Superintendent, Transformer Department, Toledo Edison Co, Toledo, Ohio

Inserting an ammeter in a standard light socket proved a fast, easy way of testing current in street-lighting circuits. The shop set-up illustrated duplicates the actual field test.

This circuit-testing meter is used in an extensive maintenance program on constant current street lighting regulators. This current reading of 6.6 amp must be accurate, as 1% over this rated value will reduce the lamp life by 10%.



EHV

EXTRA HIGH VOLTAGE TRANSMISSION ON 3 CONTINENTS

DANIEL T. BRAYMER, Assistant to the Editor

Extra high voltage transmission has many faces. Today, not only in the United States but in other countries and on other continents they have shown themselves on many major power systems.

On the pages of the special report that follow, three of these faces or aspects of extra high voltage transmission are revealed:

In Germany extra high voltage transmission at 400 kv is being used to provide a high capacity backbone superimposed on an increasingly inadequate grid that interconnects hydro plants in the Alps with coal and lignite plants scattered from the Alps to the North Sea.

In the United States two major power companies with an aggregate load of 8,000 Mw have turned to extra high voltage transmission at 345 kv to interconnect their systems and reduce reserve requirements of each by 200 Mw.

In Argentina extra high voltage transmission is being laid out to bring 700 Mw from a remote hydro site high inthe Andes Mountains 683 miles to power starved load centers around Buenos Aires at 380 kv.

Also included is a report from engineers of the Tennessee Valley Authority telling how it has cut average first cost of transmission from $80 to $42.50 per kw and its system average kw hr losses from 8¼% to 3½% in 17 years.

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TVA Cuts Transmission Outlay, Kwhr Losses . . . . . p 66

400 Kv Overlays German 220-Kv Grid

214-Mile system, operating since October, carries 600 Mw, ties into 220kv grid, links with foreign systems

GEORG V. BOLL, Chief Engineer, Technical Division, Deutsche Verbundgesellschaft, Heidelberg, Germany

The German 400-kv system, operating successfully since last October, was constructed to achieve maximum transmission capability at minimum cost and to save space. This first 214-mile section transports 600 Mw. Determination of its technical details was the joint undertaking of the Deutsche Verbundgesellschaft (DVG) and the electric supply industry.

The new EHV line is in the Federal Republic, a West German area of only 95,000 sq miles. It has 50 million inhabitants, and a population density of about 520 inhabitants to the square mile. About 4,000 utilities generate and distribute power there, the nine largest producing roughly 75% of the total. These latter established DVG for joint operation of the interconnected power system, or grid.

The new 400-kv system was dictated by the postwar increase in power consumption. This went up from 31-billion kwhr in 1948 to 86-billion in 1957, the maximum 1957 power load amounting to 17-million kw. The annual rise in generation has been 8 to 19% (average 13%), enabling power producers to equalize the big drop in power production at the war's end.

Grid at 220 Kv

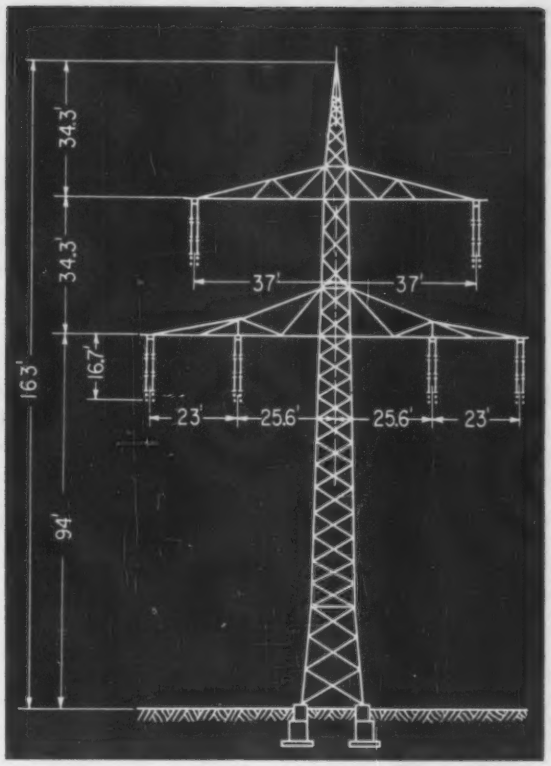
Of this power about 40% is produced by industry plants and 60% by power stations of public utilities. Of the total, 12% is generated by hydroelectric stations, 28% by stations burning lignite, and 58% by plants running on hard coal. The remaining 2% is imported from neighboring countries. Oil and natural gas are of no present importance.

Stations using lignite are in the northwest; hydro plants mainly in the south, on the slopes of the Alps. The hard-coal stations are not only near the mining districts but also spread out over the whole area from the North Sea to the Alps. All stations generating on a large scale are connected by a grid for full utilization of run-of-the-river and lignite-burning stations. Since 1929, the grid has operated at 220 kv.

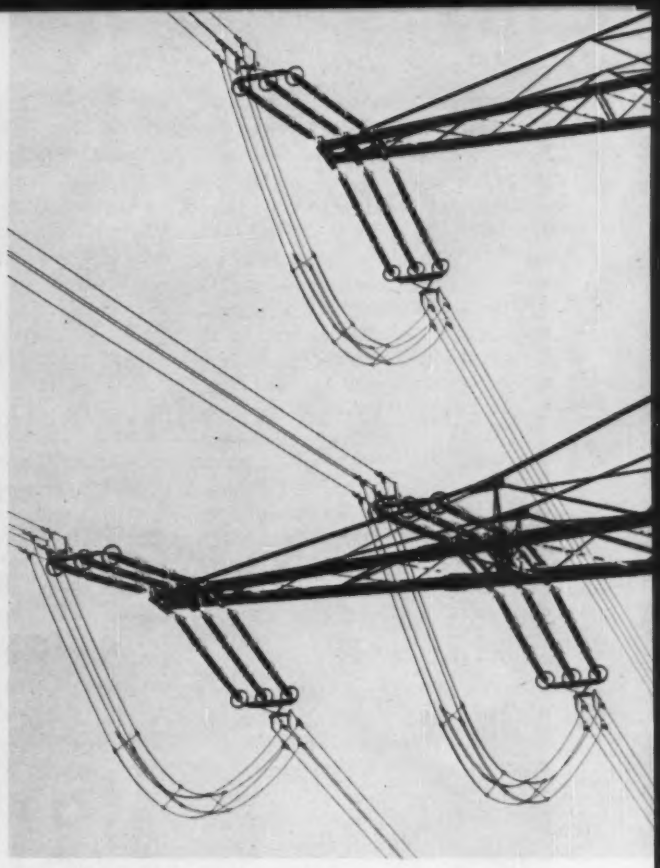
In fall and winter, the 220-kv lines operate almost continuously transmitting about 1,500 Mw from northwest to south Germany to supplement local power production. This energy transfer is lower in the warmer months, when the Alpine rivers are flooded. Power flow at night then is in the opposite direction at some points. Accordingly, the load and amount of energy transported are not definitely fixed. From this give-and-take situation arises the need for a system offering the largest possible transmission capacity at the lowest possible cost, the decisive consideration in the layout of the 400-kv lines. Another factor was the ever increasing exchange of power with other countries—Austria, Italy, Switzerland, France, Belgium, and the Netherlands.

Member companies of DVG saw clearly that transmission, coping with ever increasing demands, would make operation at 220 kv inadequate in time. With three large electric supply firms cooperating, they began developing the 400-kv

EHV SYSTEM in German Federal Republic operates between 360 and 420 kv. Some 220 kv circuits, shown heavier on map, will ultimately be 380 kv



SUSPENSION TOWERS carry two 400-kv circuits. Surge impedance is relatively low, transmission capability is high



TENSION STRINGS made up of three parallel strings of three Langstab insulators support quadruple conductors

system. Since it was put in operation there have been no difficulties.

Before 1945 a 400-kv system, with a maximum operating voltage of 440 kv, was under development in Germany. In 1954, on the basis of an agreement in the International Electrotechnical Commission (IEC), maximum operating voltage was fixed at 420 kv, and thereafter it was of international importance to specify this voltage. German planners adopted this decision. Consequently, the actual operating voltage of the new line was planned to vary between 360 and 420 kv, the nominal voltage in Germany being 380 kv.

Until 1952 German high-voltage systems operated with arc-suppression coils. These offered a high security margin in operation. Most ground faults were instantly cleared, and the system could be kept in operation after the fault long enough to allow other arrangements to be made. But after extensive studies, it was decided that the 400-kv system would be solidly grounded for the reasons that are given below:

Operation of extensive 220-kv systems in Germany and Sweden had shown that the ground-fault arc could no longer be interrupted rapidly and with certainty, even when the suppression coils were properly tuned. Rapid and sure interruption was doubtful once the residual ground-fault current exceeded about 200 amp. On the 400-kv system, residual ground-fault current was expected to exceed 200 amp. Furthermore, it was planned to interconnect the 400-kv system with the 400-kv system of neighboring countries without the interposition of coupling transformers. Thus residual ground-fault current would exceed the 200-amp limitation substantially.

It was found also that switching surges on solidly grounded systems were less severe than on systems with isolated neutrals and that switches were less affected in the clearance of short circuits. Moreover, the grounded system's insulation level could be lower than that of a system with arc-suppressing coils. When both the 400 and 220-kv systems were solidly grounded, the units in the 400/220-kv transformer bank could be autotransformers with graded insulation; they could be smaller and lighter than units with separate windings on full insulation.

Test Voltages Set

In collaboration with the Verband Deutscher Electrotechniker (VDE), test voltages were established for lines, station equipment, switchgear, and measuring and power transformers. The 50-cps test voltage for internal insulation of power and voltage transformers is 640 kv and for all other system parts 750 kv to ground. The rain test voltage did not differ much from the 781 kv used for the Swedish equipment. But where insulators were exposed to severe atmospheric pollution, the test voltage was somewhat larger; it was raised to 830 kv for the initial 400-kv equipment.

The impulse strength (1 x 50μ sec)

was selected to lie about 20% above the impulse protection level of the lightning arresters. This impulse protection level is guaranteed by the construction of the arresters. Consideration was given to the fact that, once the arresters have reacted, they still must clear, even when the 50-cps voltage of the phase to ground temporarily exceeds normal. Such a voltage increase can follow a sudden drop in load and a ground fault.

Accordingly, the impulse protection level of lightning arresters is 1,170 kv, and the base insulation level (BIL) of external and internal (transformers and opened disconnects) insulation, respectively, 1,425 and 1,640 kv. Somewhat higher test voltages were used on initial equipment.

Current Limited

As the 400-kv system is linked with the many 220-kv systems, its short-circuit current can be determined by the possible short-circuit currents of those systems to which most power stations are connected. Network analyzer tests and calculations indicated that, even were the interconnected system extensively developed, it could limit short-circuit currents by suitable means, so that

The 400-kv system would not exceed 12,000 Mva

The 220-kv system would not exceed 8,000 Mva

The 110-kv system would not exceed 4,000 Mva.

Impedance relays with graded time delays serve as protection for the 400-kv lines, as well as for the 220-kv system. A ground fault on the line trips the circuit breaker which, after an interval of 1.2 sec, automatically recloses. Total tripping time is 100 to 200m sec. As long as the 400-kv system consists of a few lines, short circuits at the station bus bars will continue to be covered by the line protection. Special bus-bar protection is yet to be provided.

Reactors Compensate

On no-load at 400-kv operating voltage, every 100 miles of line produces about 120 Mva of capacitive power per circuit. Reactors compensate for this capacitive power when the line is energized or the load is low. These are connected to the 30-kv tertiary windings of the 400-kv transformers. These transformers are constructed in 50-Mva, 3-phase units. Each line has enough reactors to compensate almost completely for the charging current. There are no synchronous condensers at present on the 400-kv system, nor on the 220 and 110-kv systems except at a single station.

But in the last few years the 110-kv system, the medium, and low-voltage systems have been balanced by the introduction of static condensers. These are used in a sufficiency that prevents reactive power from being taken from the EHV system. Up to now that system's voltage has been regulated adequately, even without synchronous condensers.

Costs Only 10% More

Originally the intention was to design a transmission system which could be operated initially with two 220-kv circuits to be converted later to a single 400-kv circuit. But such a changeover would put the line out of service for a few months. The line would cost only about 10% more, it was found, if its transmission towers, right from the beginning, were capable of carrying two 400-kv circuits. Each circuit could later be changed over from 220 to 400 kv. And two circuits always guarantee a higher degree of security in operation. Furthermore, rights-of-way are scarce in the vicinity of industrial centers where the 400-kv lines are especially needed. Accordingly, after comprehensive studies and comparisons, the suspension tower for two 400 kv circuits was decided upon.

Double Circuits on Tower

The design of the suspension towers fits well into the landscape. Surge impedance is relatively low for the distances between phases, and the transmission capability relatively high. Towers for the double-circuit, 400-kv lines on normal stretches per mile have an iron weight of 117 tons, and their foundations a concrete volume of 7,000 cu ft per mile. The cost per mile for such a line, fully equipped, is about $90,000 at the present rate of exchange.

The Langstab insulator, in general use in Germany, was selected as insulation. It is puncture-proof and can only flash over. Since the introduction of the supersonic test, this insulator has attained a high margin of security and is today fitted, almost without exception, to the German 110, 220, and 400-kv systems. An insulator string comprises three Langstab insulators suspended below one another. Although the 14-petticoat type proved satisfactory in tests at the 400-kv test station in Rheinau, with a certain degree of atmospheric pollution, the new lines were fitted with the 27-petticoat type. The latter, having a longer leakage path, was selected in the interest of a higher safety margin.

Mechanically Reliable

Suspension strings comprise two parallel strings of insulators, and tension strings three parallel strings. These provisions achieve a high mechanical reliability margin. Calculating the weight of the conductor length and the normal ice load according to VDE standards, the load on the suspension strings is only two thirds of the permissible load.

Tension-string hardware was designed so that the load is shared equally by the strings not only normally but also when one insulator string breaks. Tests under natural conditions showed that, when one insulator is broken, the line continues to be supported, even under full ice load.

Tests of up to 1 sec duration at 10,000 amp were made on grading rings to assure that even a short-circuit flashover, such as occurs in a ground fault, would not damage the insulator strings. Results were satisfactory, and the strings were subsequently fitted with the selected grading rings. These proved suitable in practical operation for the 220-kv system too.

Tested at Rheinau

The four-conductor bundle of steel reinforced aluminum cables of 0.85-in. dia, the two-conductor bundle of steel reinforced aluminum cables of 1.25-in. dia, and the 1.65-in. dia hollow copper conductor (HH) were investigated. Costs per mile of double-circuit lines made up of these conductors are in the ratio of 1.0 to 0.94 to 0.80, respectively, and their surge impedance load is in the ratio of 1.0 to 0.83 to 0.67—1,320 to 1,100 to 880 Mw. The line using a four-con-

ductor bundle arrangement thus gives minimum cost per Mw transmission capability per mile.

The electrical properties of lines with these conductor arrangements were tested over several years at Rheinau, the tests establishing that the line with four-conductor bundles showed the lowest corona losses of all conductor arrangements. Accordingly, the 400-kv lines were constructed as double-circuit lines and fitted with four-conductor bundles of steel-reinforced aluminum cables with 480 Mcm aluminum and 80 Mcm steel each. The continuous steel reinforced aluminum ground wire along the length of the cables has the same cross-section. Tests at Rheinau have shown that the radio interference from these four-conductor bundle lines is less than from the existing 220 kv lines with single conductors.

The IEC's recommendation was followed in the selection of transformers which are 400 kv with star connection and delta tertiaries. Such transformers connect the German 220 and 400-kv systems directly and without phase displacement to the corresponding systems of neighboring countries. As these were to be solidly grounded, they could be built as autotransformers. To enable their transportation by the German Federal Railway, the transformers were constructed as three single-phase units, each having a capability of 220 Mva, or 660 Mva for the 3-phase bank. They were transported complete with the 220 and 30-kv bushings, the 400-kv bushing having been removed. These are the standard designs adopted:

Autotransformers, 3 x 220/66-Mva; 400/231/30 kv

Autotransformers, 3 x 110/33 Mva; 400/231/30 kv

Transformers with separate windings, 3 x 110/33 Mva; 400/2 x 115/30 kv.

Tapchanging Provided

All 400-kv transformer banks are equipped with tapchanging gear operating over a range of ±18%, so that the changeover rate can be adapted to the changes of the operating voltage in the 220 and 400-kv systems. The regulating transformer and its tap-changing gear were included in the tank of the autotransformer, where it is excited from the delta winding of the main transformer (30 kv). This arrangement makes it possible to change the phase angle of the additional voltage by 60 deg, which has proved useful in distributing the load properly between the first 400-kv line and the parallel operating 220-kv lines of the grid.

Careful consideration was given to the extent of the short-circuit voltages of the transformers and their effect on voltage regulation within the system. Short-circuit current was also investigated.

For the expected generating capacity and the relatively short lengths of circuits it was found that the short circuit voltages of the transformers must not fall short of approximately 10%. Special consideration was also given to the short circuit voltage between the 400 kv and the 30 kv windings since the short circuit magnitudes may otherwise be extremely great on the 30 kv side.

Transformers are to be provided with differential and Buchholz protection as well as with impedance protection which will automatically disconnect transformers when bus bar short circuits occur.

Terminals of all the transformer types have been standardized. Accordingly, the transformers are easily interchangeable, as the position of all bushings is the same even when the transformer windings and core construction vary. The disconnecting switches were constructed with their gaps perpendicular instead of horizontal, a new development which saves station space. Two air blast circuit breakers have been installed.

Other Types Studied

Other types of transformers for a 300-Mva bank were studied for probable future use. These included autotransformers, and units with separate windings, having the low-tension winding in two parts, which can be connected in series for a voltage of 231 kv, or parallel for a voltage of 115 kv.

Some of the information contained in this article was presented by the author in a technical paper presented before the American Power Conference in Chicago March 26, 27 and 28 in Chicago.

Insulation Level for European 380-Kv Systems with Solidly Grounded Neutral

		Germany		France	Russia	Sweden	
		380 Standards (VDE*)	First Plant			First Plant	Later Plant
Nominal voltage			380	380	400	380	
Maximum operation voltage			420	420	420	420	
Overhead line	p.w.v.	750	830	850	775	760	690*
	i.w.v.*	1425	1800	1850	1800 to 2000	1800	1500*
Station Equipment							
Open-air bushings	p.w.v.	1050	1220		1150	825*	
	i.w.v.*	1640	1800	1750	1900	1725*	
Internal insulation	p.w.v.	750	830	730	850	781	660*
	i.w.v.*	1425	1450	1650	1500	1775	1500*
Neutral insulation	p.w.v.	640	640	630	700	780	660*
	i.w.v.	1640*	1800*	1450	1500	1775	1500*

p.w.v. = 50 cps power withstand voltage
i.w.v. = impulse withstand voltage (1 x 50 μs wave)
* = VDE publication 0111/3.58
= for new plants except measuring transformers and switches
= presently under discussion
= dust seize
= with damped wave

345-Kv Interconnects Two 4000 Mw

Commonwealth Edison-American EP interconnection will permit each to reduce its generating reserve by 200 Mw

M. J. LACOPO, Interconnection Engineer, American Electric Power Service Corp*, New York, N. Y.

L. F. LISCHER, Protection Planning Engineer, Commonwealth Edison Co, Chicago, Ill.

A new 345-kv interconnection, placed in operation this month now links the Commonwealth Edison Co and American Electric Power Co systems, which had a totaled combined load of nearly 8,000 Mw in 1957. The tie will permit a 200-Mw reduction in generating reserve by each participant, and its co-builders have established the basic engineering and economic soundness of their selection of the 345-kv line.

The double-circuit steel-tower transmission line is about 92 miles in length and it utilizes 1,414-MCM expanded ACSR conductors, 1.75 in. in dia. It will join Indiana & Michigan Co's Olive Substation near New Carlisle, Ind., and Edison's Goodings Grove Substation some 25 miles from downtown Chicago. A number of different factors considered before the decision to interconnect at 345 kv were:

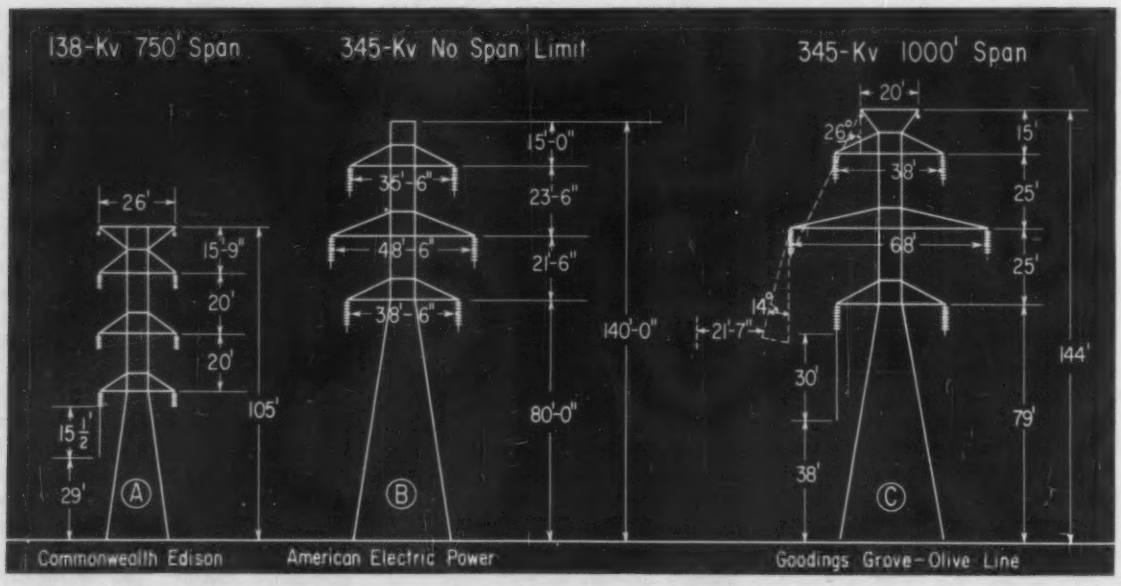
- Each system's load of about 4,000 Mw.
- The fact that Edison is installing turbine-generators with a capacity of 305 Mw, and AEP's Breed and Sporn Plants will have 450-Mw units.
- The potential benefits of interconnected operation, such as improved continuity and quality of service, conservation of materials, and economies in capital and operating costs.
- The nation's interest in event of national emergency, when the line would link in the 345-kv transmission extending from West Virginia to Illinois.

Some immediate advantages expected by Edison and AEP are reflected in the provisions of three service schedules for delivery of electric energy to effect emergency assistance, operating economies, coordination of maintenance schedules, and other mutual benefits. The tie is in step with the present and has the flexibility and capacity to keep pace with the future.

Edison operates a relatively close-knit system in the northern third of Illinois; AEP companies serve customers in seven states over an extensive, integrated transmission network of 345 and 138-kv lines. Realization of the many potential and important benefits of interconnected operation arose from these facts: Both systems have about the same load and generating capacity and yet there are major differences in the characteristics of the two systems.

The Edison system covers some 11,000 sq miles in serving more than 1,930,000 customers. Its 12 steam-electric generating stations supply the system load and are integrated by approximately 1,480 circuit miles of 138-kv transmission lines and one 147-mile, 230-kv line. More than half the total load is in a 200-sq-mile area. Besides those to the east, the system has interconnections with four other utilities.

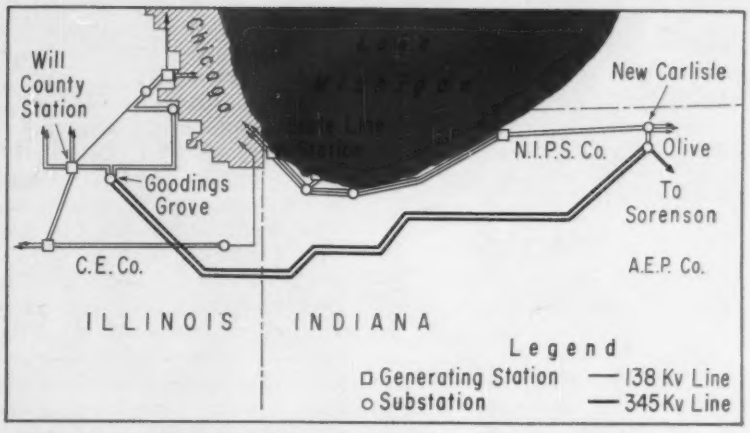
* Formerly American Gas and Electric Service Corp.



COMPARISON of 138 and 345 kv towers show evolution of Goodings Grove-Olive structure. At A is tower used on Edison system to control conductor galloping. At B is 345 kv tower used on AEP and OVEC systems. C is new tower

Systems

The AEP system comprises six operating electric utility companies, providing power to more than 1,350,000 customers in Indiana, Michigan, Ohio, West Virginia, Virginia, Kentucky, and Tennessee. In 1957 97% of its power was generated by 11 major steam-electric (coal-fired) plants, all but one in the heart of the country's coal fields. All plants are integrated to form a single major power system, composed of 12,000 circuit miles of transmission lines at 345 and 138 kv. Its territory is about 49,000 sq miles. Completion of the interconnection with Edison will give AEP direct high-voltage interconnections with 15 neighboring major power systems.



345-KV INTERCONNECTION between Olive Substation at the east end and Goodings Grove Substation of the west ties Edison and American EP systems

Systems Long Interconnected

The Edison and AEP systems have operated interconnectedly for almost 30 years through an indirect link via State Line Station and the 138-kv system of the Northern Indiana Public Service Co. This indirect connection became inadequate for the interchange of appreciable amounts of power as system loads grew and larger generating units were introduced.

When any one of several companies tied together in an interconnected systems' operation suffers a sudden forced outage of a large unit, its deficit in generation is largely made up by instantaneous power flow over its interconnections. This flow may be very heavy and, although brief, lasts until load control measures are effected to increase the generation on the system that has sustained the loss. Yet duration of such tie loadings is long enough for transmission-line operation to be seriously jeopardized. The heaviest loaded line may trip on action of the line back-up relays. In which event, the system with the generation deficit might be isolated through cascade tripping of the lines. Such tripping is more probable now that Edison and AEP are using generators as large as 305 and 450 Mw, respectively.

Studies with a view to increasing interconnection capacity between Edison and AEP systems at either 138-kv or a higher voltage showed conclusively that a reasonable reinforcement at 138-kv would not provide sufficient transmission capacity. They showed that 345-kv transmission, of which AEP had more than 650 circuit miles in service, was more economical for the power and distances involved.

Reserve Could Be Cut

Further study indicated that an interconnection of adequate capacity would allow both companies to decrease their own generating reserve capacity safely and economically. This finding merely recognized the improbability of major trouble on both systems simultaneously. Two systems tied together directly through a high-capacity link have the same degree of service reliability with fewer total kw of generating capacity. Such reliability would not be obtained were the systems operating separately, or with a lower-capacity tie.

Edison and AEP believe that their respective initial saving in owned generator reserve will be about 200 Mw.

Two circuits are required. Were only one installed, any forced outage on it would cause the interrupted power to flow through the lower-voltage interconnection with all of its limitations. At Goodings Grove each 345-kv circuit terminates directly in a 160 Mva autotransformer stepping down to 138 kv and connecting to a bus through which two nearby 138-kv circuits have been looped.

Additions Planned

Initially the tie capacity will be limited by the 320 Mva of transformer capacity which, of course, does not utilize the full capability of the 345-kv double-circuit lines. In emergency conditions substantially higher transformer loadings are permissible for limited periods. But subsequent additions of transformer capacity are planned, along with a 345-kv bus with connections to the future Edison 345-kv network. It is expected that the interconnection will then be capable of carrying 500 Mw continuously, allowing for emergency loadings as high as 1,000 Mw.

Goodings Grove Substation is most favorably situated for obtaining overall economies. Such location not only permits efficient use of adequate existing transmission capacity in the 138-kv network there, but is strategic with regard to present and future generating stations and load centers. For many reasons, Goodings Grove fits logically and economically into plans for Edison's anticipated 345-kv system development.

Olive Substation will have a 345-kv bus with autotransformers, connecting to I&M's 138-kv network at New Carlisle. I&M will build some 78 miles of 345-kv line from Olive Substation to its Sorenson Substation near Fort Wayne, where the line will connect with the existing 345-kv network of the AEP system. These connections will provide a strong high-capacity trans-

mission link between the backbones of the two systems. The 345-kv interconnection, in avoiding the heavily built-up areas of northwestern Indiana, does not follow the shortest route. But the route selected has the lowest attainable total cost (right-of-way plus transmission line).

Conductors Not Bundled

Both the Chicago and the Indiana areas are subject to occasional sleet storms which may result in "galloping" conductors on transmission lines. The problem in the Chicago area had been attacked in two ways, first by direct melting of sleet by the application of short circuit currents, and second by special designs of steel tower lines using increased conductor spacing and shortened span lengths. Such special design was first used in 1940 on a 147-mile 230-kv line. This line has had no trip outs due to galloping conductors in 18 years. On the AEP system, routine sleet melting procedures, principally by the direct application of 138-kv short-circuit current, had been practiced with considerable success for many years.

For the 92 mile line from Goodings Grove to Olive, however, direct melting was not feasible. The distance was too great to obtain adequate melting current by a single application of 138 kv and the cost of other expedients, such as applying a higher voltage or splitting the line in two parts, was prohibitive.

The solution which was worked out jointly by the engineers of the two companies, was a combination of a shorter span length, 1,000 ft maximum, and a special tower design with a considerably increased horizontal separation between middle, bottom and top conductors in order to prevent galloping conductors from coming in contact and tripping out the line.

The evolution of this new design is illustrated on page 60. In this figure, "A" shows a 138-kv double circuit tower used on the Edison System along with a maximum 750 ft span to control conductor galloping during ice storms. The conventional 345-kv double circuit tower previously used on the AEP and OVEC systems with no specific span limitation and smaller horizontal offset for the middle conductor is shown at B, page 60. The 345-kv double-circuit design worked out for the Goodings Grove-Olive line with a 1,000 ft maximum span is shown in drawing C page 60.

Conductors used on this line, as on the OVEC 345-kv lines and on later designs on the AEP system are single 1,414 MCM expanded ACSR, having two layers of paper twine filler surrounding the steel core. Imbedded in each of these layers are two spiraled aluminum wires acting as spacers. Two layers of aluminum strands complete the conductor. Although corona and radio interference problems are not anticipated, the conductors on this line were installed with tension stringing equipment, as shown in ABC to insure freedom from abrasives and contamination from dirt during the stringing. Both the main conductors and the two 159 MCM ground wires are protected by vibration dampers.

Recent investigations of lightning flashover phenomena indicate that steep wave-front lightning surges tend to follow the cascade striking distance over insulators along the surfaces rather than the tight-string distance (shortest path) from conductor to tower. Accordingly, suspension strings comprise 21 5-in. instead of 18 5¾-in. insulators, actual string lengths being nearly equal.

Designed for Expansion

The Goodings Grove Substation terminal is designed for the ready installation of additional facilities. The 345/138-kv autotransformers are 3-phase FOA with a 12-kv delta tertiary winding, and each transformer has winding ratings of 160 and 180 Mva at 345 and 138-kv, respectively. The 345-kv winding is actually rated 330 kv with a 2 plus and 2 minus 2½% fixed taps and a BIL of 1,050 kv. The 264-kv lightning arresters, mounted self-supporting, will limit voltage on the winding to 800 kv for a 20,000 amp lightning discharge. The 138-kv portion of the winding has a 115-kv class insulation. External portions of the 345-kv bushings have a 1,300-kv BIL conforming to that of the bus and disconnect insulators.

Reactive kva requirements for the 345-kv lines and the 138-kv system dictate that kvar (lagging) be absorbed from the system under light-load conditions. Under heavy load, kvar will be supplied to the system. Although these requirements at Goodings Grove might have been met by switched shunt reactors and shunt capacitors, studies showed that synchronous condensers were slightly more economical. This takes into account the inherent ability of condensers to give considerable kvar support in transient conditions.

Accordingly, two 12.6-kv, 62.5-Mva, hydrogen-cooled synchronous condensers have each been connected to the 12-kv delta winding of its respective autotransformer. Cooling water for the hydrogen coolers comes from two driven wells, and a third well takes the coolers' discharge. Thus regeneration of supply to the source wells is provided. Space has been provided for two additional condensers which the installation of more transformer capacity may require. As the condensers will run almost continuously, starting and stopping only infrequently, "across-the-line" starting will eliminate the cost of the customary reduced-voltage starting equipment.

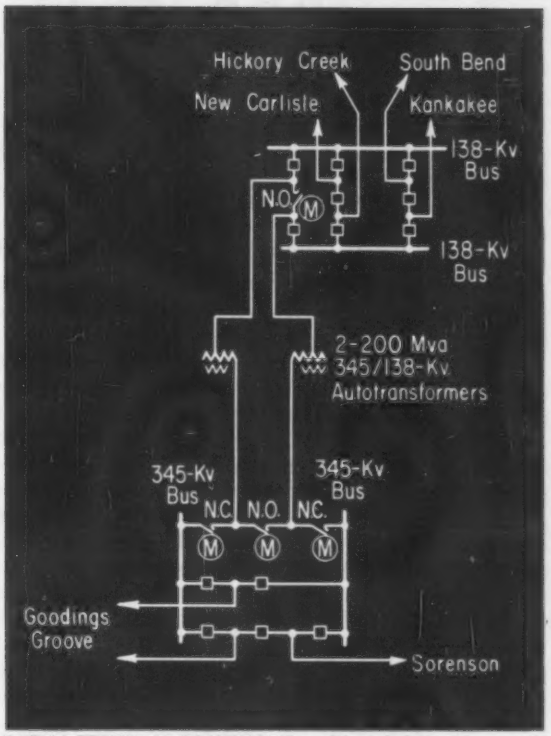
Use Carrier Relaying

Primary relay protection for the 345-kv circuits consists of directional comparison carrier relaying. As there are no 345-kv circuit breakers at Goodings Grove, the transformer differential relays operate via a carrier-current transfer-trip channel to open the 345-kv breaker at Olive Substation for a transformer fault. Back-up protection is provided by mho distance and directional ground relays.

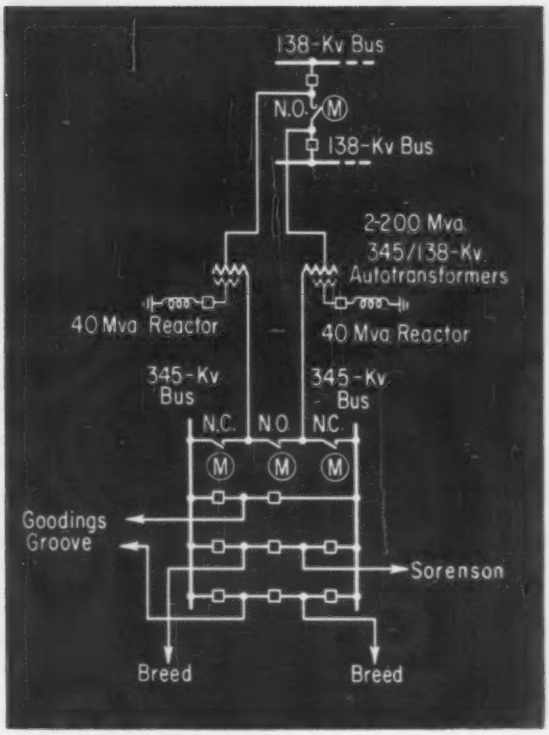
Omission of overload relays on the Goodings Grove transformers prevents opening of the tie under severe loading conditions in a system emergency. From a system-operating viewpoint, terminals at either end of the interconnection are considered each as a generator connected to its respective system.

The new 345-kv interconnection is in parallel with the existing 138-kv tie through the NIPS system. Electrical characteristics of the two parallel paths are such that for a given flow of energy between AEP and Edison only 60% of the total would flow over the 345-kv tie and the remainder through the NIPS system.

This situation would have im-



INITIAL TERMINAL EQUIPMENT at Olive Substation on AEP System includes two 345/138-kv step-down autotransformers



ULTIMATE OLIVE SUBSTATION will have two 40-Mva switched reactors for absorbing excess charging kva

posed a serious limitation on the overall capability of the interconnections because the 138-kv system would have been seriously overloaded. The simple solution of opening the lower-voltage tie at a strategic location was not possible because of electrical considerations and contractual arrangements between NIPS and Edison and between NIPS and I&M. Similarly, lowering the impedance of the 345-kv tie by means of series capacitors was impracticable, as even 100% neutralization of the line reactance would not solve the problem.

Consequently, a ±38-deg phase-shifting transformer, with a thermal rating of 100 Mva, was installed at State Line Station. This station's two 22-kv buses made it a suitable location for this installation. The bus arrangement, together with the fact that all generators and transformers for the Edison and NIPS lines have double-circuit breakers, permits connection of any one element to either bus.

During normal operation the phase shifter will be connected between the two buses. All lines to the Edison system will be connected to the so-called Edison bus, and all lines to the NIPS system to the so-called NIPS bus. Generators may be switched from one bus to the other, as changing load conditions require.

Is Reliable, Flexible

Phase-angle control on the phase-shifting transformer is obtained without appreciably affecting voltage magnitudes on the two buses appreciably with changes in tap position. This is done by using an angle-shifting voltage which is taken at right angles to the bisector of the angle between the two bus voltages. The control objective is, of course, to have taps in a position that allows very little energy to flow through the NIPS system during deliveries between Edison and AEP.

Microwave equipment will perform tie-line telemetering for control of the phase shifter, as well as for system load control. In general, measurements of energy flow at interconnection points in the New Carlisle area are transmitted to State Line Station via a channel of the established NIPS microwave equipment between the New Carlisle and State Line terminals.

The 345-kv interconnection terminates on the AEP system at Olive Substation, from where a 78-mile, 345-kv line to Sorenson Substation, completes the connection with the main 345-kv network of the AEP system. Two 345-kv circuits from Breed Plant of I&M, to be completed in 1959, will terminate at Olive Substation. This 450,000 kw of generating capacity connected directly to this station will further strengthen the interconnection.

Besides the 345-kv switching, Olive Substation will have two 345/138-kv step-down autotransformers of 200 Mva each as an important supply point for the I&M 138-kv system. When the Breed circuits are brought in, two 40-Mva switched reactors connected to the 13.2-kv tertiaries of these transformers will absorb excess charging kva of the 345-kv lines. The 345-kv and 138-kv switching layouts, both employing the 1½ circuit-breaker scheme, will provide a high degree of reliability and flexibility.

Argentina Plans Long 380-Kv Line

682-Mile, single-circuit, steel-tower line to transmit 700 Mw to Buenos Aires when El Chocon goes into operation in 1962

BUENOS AIRES (McGraw-Hill World News)—The initial design for Argentina's new 682-mile, 380-kv, single-circuit, steel-tower transmission line is expected to be completed at the end of this year. This line, so important in the country's effort to bring cheap hydro-electric power to its production centers, is scheduled for completion in 1962, when the El Chocon hydro-electric station will be ready for operation.

Argentina's present power requirements about double its present capability of approximately 2-million kw, 95% of which is thermally generated. As fuel imports to keep Argentina's thermal power plants in operation last year boosted its oil import bill to an intolerable $320 million, the government has given priority to hydro-electric development.

Annual per-capita consumption in Greater Buenos Aires is 600 kwhr, but the rest of the country averages only 150 kwhr.

The new, abnormally long line will bring 700 Mw of power from the El Chocon hydro station, in the Patagonian province of Neuquen, to Greater Buenos Aires's consumer centers. Preliminary studies for this project began in January.

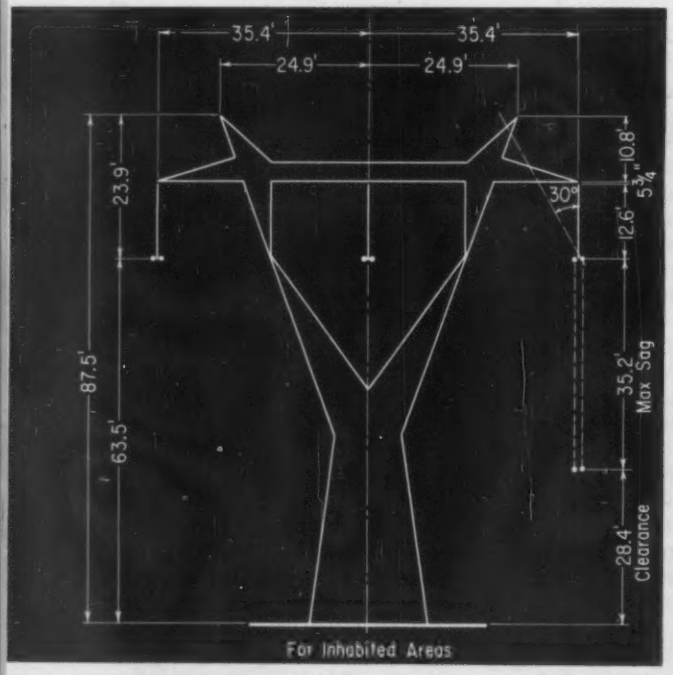
Contract for the design of this line has been awarded by the Argentine Water & Power Board (Agua y Energia Electrica-EN) to S.E.P.E. (Sociedad de Estudios y Proyectos de Electrificacion). The latter is a consortium of Italian and Swedish experts, sponsored by the Italian construction company, TECHINT (Compania Tecnia Internacional).

Station Will Supply 700 Mw

Argentina's water resources originate on the far western slopes of the Andes Mountains. Their development has been handicapped by the great distances separating them from consumer centers clustered along the Atlantic coast. The projected hydro plant nearest to these centers is the Salto Grande Station on the Uruguay River. This station will ultimately supply 700 Mw to Buenos Aires over 280 miles. Complex international negotiations, however, may delay construction there for several years.

Another major project, involving exploitation of the Mendoza Province rivers, has been postponed until after completion of El Chocon project on the Limay River. Ultimately it will bring 400 Mw 650 miles to the Buenos Aires area.

A 127-mile section of a future 132-kv line from Buenos Aires to San Nicolas is already completed. This double-circuit line will transport 135 Mw from the thermal San Nicolas station to Buenos Aires. This is



DELTA-TYPE suspension steel towers will carry two conductors per phase through inhabited areas crossed by line

El Chocon-Buenos Aires Transmission Line

Voltage	380 Kv
Length	682 Miles
Construction	Single-circuit delta and portal guyed steel towers
Design Loading	Ice-free, maximum wind 75 mph; no broken conductors
Ruling Span	1150 Ft
Insulators	Standard 10 x 5¾-in. 25,000 lb
Suspension	Single string, 22 units
Dead End	Quadruple string, 24 each string
Line Conductors	Multiple, ACSR (54 Al/19 St), Approx. Dia, 2 in. Approx Area 2,385 Mcm
	Number of conductors per phase: 2 or 3, spaced 15¾ in.
Overhead Ground Wires	Two of galvanized steel, ½ in., 19 strands
	Tensile strength 170,000 psi
Isokeraunic Level	40
Corona Loss	1.13 Kw/mile in good weather
Phase Distance	34.5 Ft for 2 conductors per phase
	39.7 Ft for 3 conductors per phase
Protection Angle	30 Deg.

From Hydro Site

a temporary arrangement. Once completed to Mendoza, the line will be reduced to a single circuit for operation at 380 kv with twin conductors. The same towers and conductors will be used at the higher voltage, only the spacings being changed to minimize transforming losses.

Water & Power Board studies of the El Chocon project show that the average flow volume of the Limay River is 2,718 cfs, and that exploitation of its water is practicable. Priority is given to the 700-Mw power station at El Chocon Falls, whose yearly output has been calculated at 2,800 million kwhr. Some 500 to 600 Mw will go to Buenos Aires; the rest to the Patagonian area.

Opening of bids for this three-year project will take place September 22, and awards are expected in 1959.

Studies for the transmission line's design are in an early stage, so that relatively little technical information is available. Those engaged in experiments and studies are: Prof. Agustin Dalla Verde, president of Asociación Electrotécnia Italiana and general technical manager of the Societá Idroelettrica Piemonte, and his staff; Ake Rusk, president, and Gunnar Jancke, director of investigation and chief engineer of the Swedish State Power Board.

Half of the line will cross the shrub-covered Patagonian desert where there are no considerable differences of elevation or river crossings. Highest point of the line will be 984 ft at El Chocon. Servicing a line through and establishing bases in an almost uninhabited zone, without water supply and roads, will be difficult.

MAP shows projected El Chocon-Buenos Aires transmission line and the interconnection which will be made with Mendoza Province power generating sites

Among transmission system choices, these two have emerged as deserving further investigation:

1. A line that will be divided into three stages of equal length. At intermeditae points, compensating substations will be built and equipped with condensers installed in series. Shunt reactors will be installed at Chocon, and synchronized condensers at the terminal station at Buenos Aires. Rate of compensation will be about 60%.

2. A line that will be divided into four stages of equal length. The mid-line substation will have shunt reactors, and the other substations condensers in series. Compensation rate and compensation in the substations at Buenos Aires and El Chocon will be about 60%.

Final decision on the transmission method will be made on the basis of results of network analyzer tests being conducted now in Italy.

Line-voltage studies are being made to establish the most practical line tension. Voltages up to 500 kv are being considered. But S.E.P.E. experts foresee that 380 kv will be chosen for the line voltage because a second line has been planned to parallel the first one. This line will be easier to service and will afford more secure transmission, once the three remaining stages of the Limay River power project are completed.

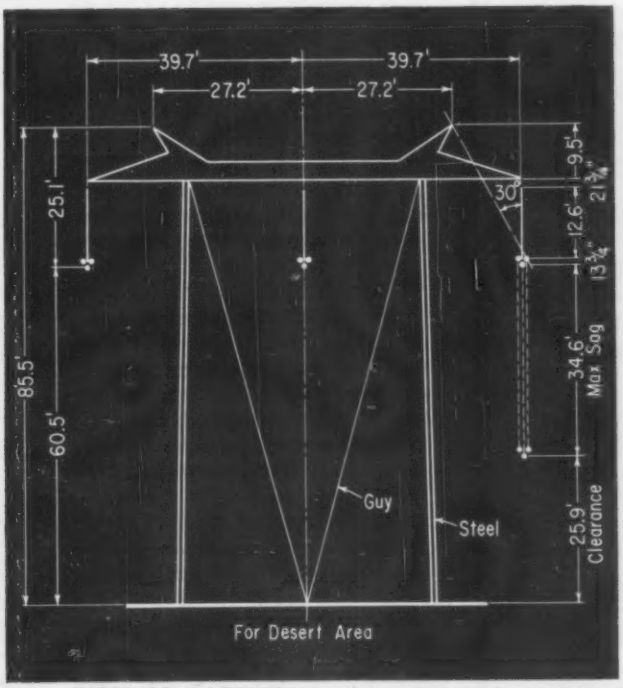
Interconnection a Factor

This second line at 380 kv, S.E.P.E. experts argue, will simplify the final interconnection of earlier projects with other hydro stations in the rest of the country. The Mendoza-Buenos Aires line is projected for this voltage.

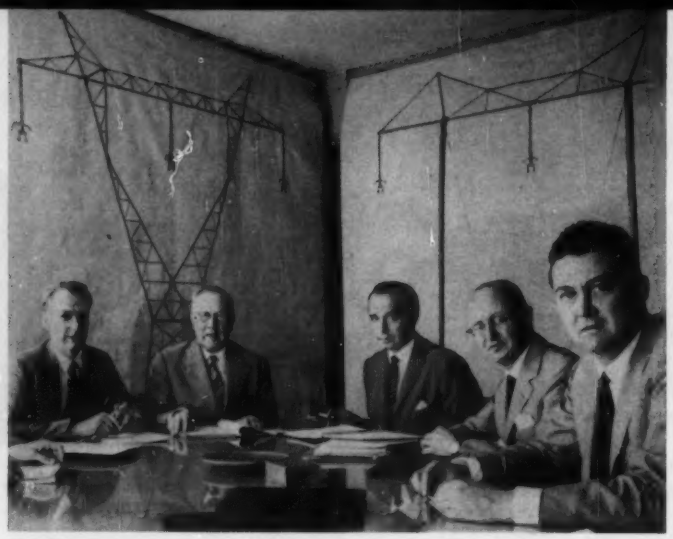
Some 3,000 steel towers—one every 1200 ft—will stud the line for its entire length. Two basic tower designs have emerged so far—one of the delta type for the desert country, and one of the trestle bent type for the more populated areas. Those for the desert zone can be built much cheaper, as overhead ground wires will need no protection.

S.E.P.E. specialists agree that erection of the 682-mile line involves no real insurmountable difficulties.

(*Continued on page* 66)



THREE CONDUCTORS per phase characterizes the steel towers designed for stretches of Patagonian desert

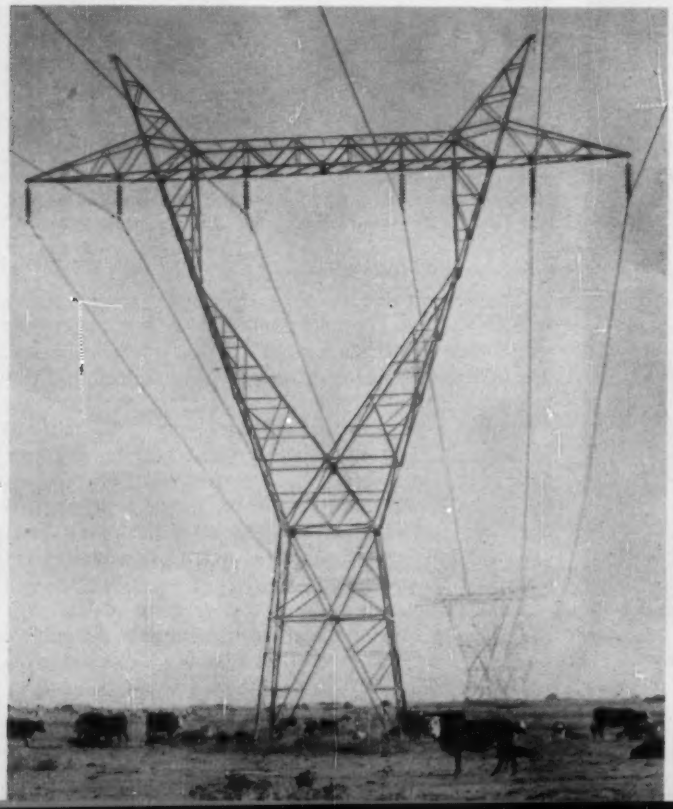


ENGINEERS on project include: Gunnar Jancke, Sweden; Agostino Dalla Verde, Italy; Adam Astromeski, Italo Camera, and Andrea Bacchelli, all of S.E.P.E. consultants of Argentine Water and Power Board

Climate promises low corona loss, and installation of condensers in series and shunt reactors will assure stability under switching conditions and prevent overvoltage in load disconnecting.

Although a detailed budget for the transmission line has not been set up yet, total-cost estimates of the El Chocon project, including the transmission line, go as high as $180 million. Of this, $80 million will be needed for the importation of electrical equipment and installations. The remaining $100 million will be used to finance such civil works as the dam, the power station, and the transmission line.

SUSPENSION TOWER of the double-circuit 132-kv line which is convertible to a single-circuit 380-kv line in future



TVA Cuts

In 17 years wrings progressive economies from transmission, other system elements

MERRILL DeMERIT, Chief Power Engineer, **K. E. HAPGOOD**, Director, Power Engineering & Construction, Tennessee Valley Authority, Chattanooga, Tenn.

The Tennessee Valley Authority, has decreased total system investment over the last 17 years from an average first cost of $80 to $42.50 per kw while cutting the system's average kwhr losses from 8¼ to 3½%. Components involved are major transmission lines, bulk or high-voltage substations, subtransmission lines, distribution substations, and power plant switchyards.

Comparing systems can mislead unless all factors are considered, a cardinal one being isokeraunic level. In the TVA 80,000 sq-mile service area, it is 55 to 65; elsewhere it's lower. Where it is only 5 to 10, reliable transmission lines and transformers cost much less.

Mutual confidence and cooperation between the engineering and operating divisions are a prerequisite to making a real dent in both costs and losses. These were in agreement in 1940, when TVA connected two generating stations having a total capacity of 120,000 kw by a single 40-mile, 161-kv line with minimum counterpoise. Earlier plans proposed three or more lines.

Hold Lines to Minimum

When the two plants were increased to a total capacity of 240,000 kw, another 161-kv line was constructed where a line had not been considered originally. The two 161-kv lines have been permanently useful. In such manner, with 161-kv lines always held to a minimum, TVA developed its system.

TVA serves directly two very large blocks of load, each having a large steam plant close by. The proximity of these steam plants has not been instrumental in reducing transmission investment and cost. At least 20% of these loads is transmitted long distances with high

Transmission Outlay, Kwhr Losses

losses—average losses for the total equal or exceed system average.

Transmission lines and substations have been located and constructed with ample features for low operating costs. Automatic equipment and supervisory control have been incorporated to the maximum feasible extent, even though their use tends to increase the cost per kw. In many instances, as at the 161-kv Columbia Substation, one group of operators operate two or more major or high-voltage substations. Two operators constitute each of three shifts there and operate three additional substations by supervisory control. The four substations—three transforming from 161 to 46 kv—having a capacity of 625,000 kva are operated from one point by a single crew.

The problem of determining hour-to-hour economical location of steam generation is less involved on the TVA system than on many others. The losses on the large-conductor, 161-kv transmission ties are about 2%, and the present normal spread of generating costs among large steam plants only 0.4 mill, or only 0.2 mill when one remote plant is disregarded.

Line Construction Deferred

TVA delays construction of transmission lines forming the network and overloads the balance of the network in an area for three, four, or five years. This overloading continues until TVA is certain that the new line will be permanently useful. This reasoning extends to transformer banks. TVA waits as long as possible before definitely planning a particular line. TVA recognizes that when money is spent for adding transmission lines, fixed and operating charges continue for the life of the line, 30 to 40 years, but maximum losses may be experienced only part of the period.

Standardization of distribution voltages at the highest level consistent with overall economy is another important approach. Since much of the original system was acquired facilities constructed by small utilities, the TVA area had not only 2.4 and 4.1 kv distribution voltages, but also 11, 12.45, and 13.8 kv. Most power was distributed at 2.4 or 4.1 kv. But the growing rural distribution required a higher voltage for economical operation, and the best compromise was 12.45 kv.

TVA found that 12.45-kv distribution is more economical than 2.4 and 4.1 kv where the latter voltages were economical years ago. A considerable selling job has been necessary, and changes have been made only where distributors have been convinced that they would be economical.

In like manner, TVA has urged directly served customers, such as those having electrochemical operations, to transform directly from subtransmission to utilization voltage, as from 46 kv to 200 v for electric furnace operation. These activities have brought changes simplifying or obviating substations in new connections, thus reducing transmission cost per kw of load and percentage transmission losses.

One important element in reducing transmission costs and losses has been the practice of using the fewest distribution substations of the largest capacity. Costs among companies vary greatly. In the TVA area, a 1,500-kva substation, with relays and low-voltage oil circuit breakers, costs $53 per kva. A 6,000-kva substation costs $20; a 15,000-kva one $12, and a 20,000-kva substation $10.

Substations Size Increased

In 1940 TVA had 200 distribution substations averaging 1,750 kva in capacity. By 1957, it had increased capacities of old substations and/or constructed new ones so that it had 295 distribution substations averaging 8,650 kva. This increase took study and many conferences with the managers and boards of directors of the 151 distributors who construct, own, and operate their own distribution systems.

No. 2 ACSR was considered large for rural feeders until studies of overall economy indicated many feeder circuits of 397.5 to 636-MCM ACSR were economical for 12.5-kv distribution from substations of 46 and 69 kv. TVA worked

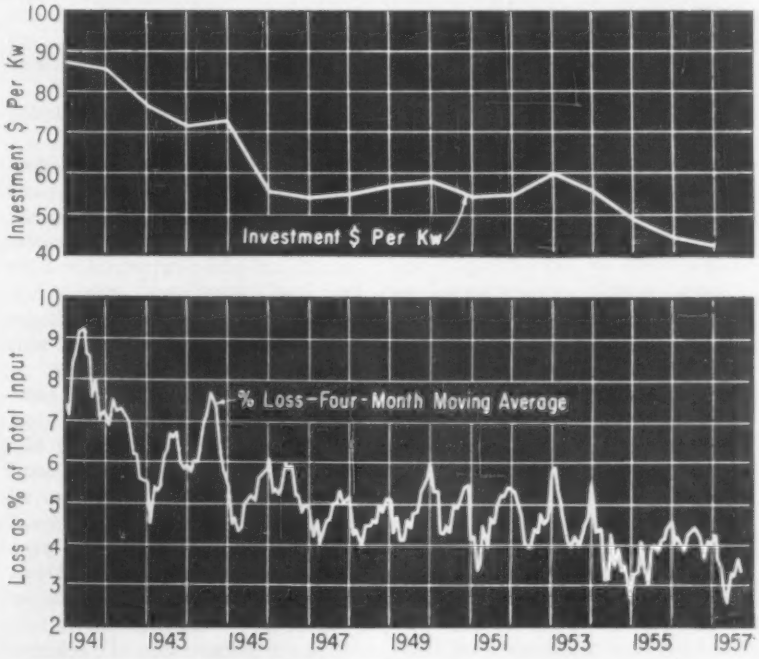


FIG 1—SYSTEM INVESTMENT AND LOSSES on TVA system since 1941. Authors expect investment to be cut to $35 per kw and kwhr to about 3½%

on the principle that all new service points should be so located that the total expenditures by the distributor and TVA would be minimal. Many approaches to the general problem of reducing transmission costs have little individual effect, yet have a noticeable effect in the aggregate. Two examples of several, are the regulation of substation voltages by the regulation of the generating station's 161-kv buses, and the location of distribution substations.

Since its beginning TVA has used no-load taps in switchyard transformers and generator flexibility for varying station bus voltage over a range of 154 to 180 kv to regulate voltage at major high-voltage and distribution substations. This practice obviates the use of many 46 and 69-kv regulators, as well as several distribution regulators, thus reducing costs and losses.

TVA believes that the term "load center" has reasonable justification where the distribution voltage is 2.4 kv, but a lesser justification where it is 12.5 kv. The relative unimportance of situating a substation at the load center may be indicated by considering the equivalent electrical distances for lines at different voltages. For instance, at 2.4 kv a line of a given size and spacing carries a given load 500 ft with a definite percentage voltage drop and percent loss. At 12.5 kv, a line of the same size carries the same load 2.5 miles with the same voltage drop and loss.

TVA serves many distribution substations by 46 or 69 kv radial transmission lines. Generally, this is where the load is less than 15,000 kw. Emergency type loads, such as hospitals and water-pumping stations, usually can be served by 13-kv-line interconnections. These 46 and 69-kv lines have greater than normal strength and lightning protection through suspension insulators and ground wires with a lightning-rod type of grounding on each pole. Usually two or three substations are connected to one transmission line. When loads in such areas exceed 15,000 kw, TVA may construct loop lines by building ties between two remote substations and installing two 46 or 69-kv oil circuit breakers in every second or third substation in the loops. Besides giving adequate service, these high-grade radial lines reduce the cost per kw of transmission over loops of lower-grade construction.

In rather large, low-density-load areas whose load is rapidly increasing, it is necessary to invest excessively in substation transformers or replace transformers frequently. The substation structure which TVA has designed for 46 or 69 kv, is somewhat expensive for very small substations but more economical for larger ones. It is designed so that substation capacity can be increased from 1,500 to 50,000 kw without a major modification of structure or yard. Studies indicate that it is economical to install transformer banks of 20,000 kva and less that will last five to eight years and banks larger than 20,000 kva adequate for eight to 12 years. Cost per kva of transformer banks decreases quite rapidly as the size increases, so TVA buys only large transformers to replace smaller ones and uses the smaller ones to replace still smaller banks, etc.

Load Transformers To Capability

Instead of following the ASA recommended practices, TVA uses the actual capability of each specific transformer as determined by heat runs. On the average, substation transformers carry a winter-peak load of 170 to 200% of nameplate rating for the short period of house heating. Shop examination has shown that transformers thus loaded suffer no harm in operation.

In 1940 TVA had transmission voltages of 161, 110, 69, 46, 33, and 22 kv. The 110 kv was generally served by autotransformers from the 161 kv, this requiring the purchase of large autotransformers for replacement whenever the 110-kv load increased appreciably. Studies comparing the two voltages with 161 kv resulted in TVA's eliminating the 110 kv except where it interconnects with neighboring companies' 110-kv transmission. Most 110-kv lines were changed to 161 kv. This was done gradually, and the autotransformers were moved to interconnecting lines to boost their capacity. Changes were over several years, so that no plant was sacrificed and an overall reduction in cost per kw was realized.

The requirements of reactive power and the locations and methods of its generation constitute an important transmission problem. The capacity of a 161-kv line of 795-MCM ACSR, 100 miles long, at 10% voltage drop, is 45,000 kw at .80 pf; 126,000 kw at unity pf, and 179,000 kw at .98 pf leading. Transmitting reactive power any appreciable distance, except in small quantities, is uneconomical, especially when the ratio of reactance to resistance of lines is 5 to 1, or greater, as on the TVA system.

In TVA's calculating board studies, the reactive generating capacity of the generators was used up to the economical limit; synchronous condensers and/or capacitors were used at the major primary substations and at the distribution substations; and capacitors on the distributors' systems. It was found that the points of generation of reactive power are most important. Reactive power requirements consist not only of the reactive power required at and by the load, but usually greater amounts are required by the I^2X used by distribution lines, 69 and 161 kv transmission lines, and the exciting current and I^2X in distribution and substation transformers.

Fig 2 shows results of studies, including estimates of cost, used in 1950 for determining the location of reactive power generating equipment. The studies show that greatest economy was had with a large number of capacitors on the distribution systems. This presented TVA with a problem: The distribution systems are owned by the distributors, and the rate schedule has a power-factor provision.

TVA worked out a "cooperative capacitor plan" whereby it furnishes capacitors to the distributors who install and operate them on their systems at points determined jointly by TVA and themselves. The distributor benefits in the level of voltage along circuits, reduction of system losses, and increase in circuit capacities. TVA gets the reactive power of these capacitors by adding the rated capacity of the cooperative units to that metered at the service point. The distributor gets his benefits for about $1 per kvar, and TVA obtains the equivalent of capacitors at the substation for the cost of capacitors delivered, ranging from $4.50 to $6.00 per kvar.

TVA has capacitors also at substations where economical, and a total

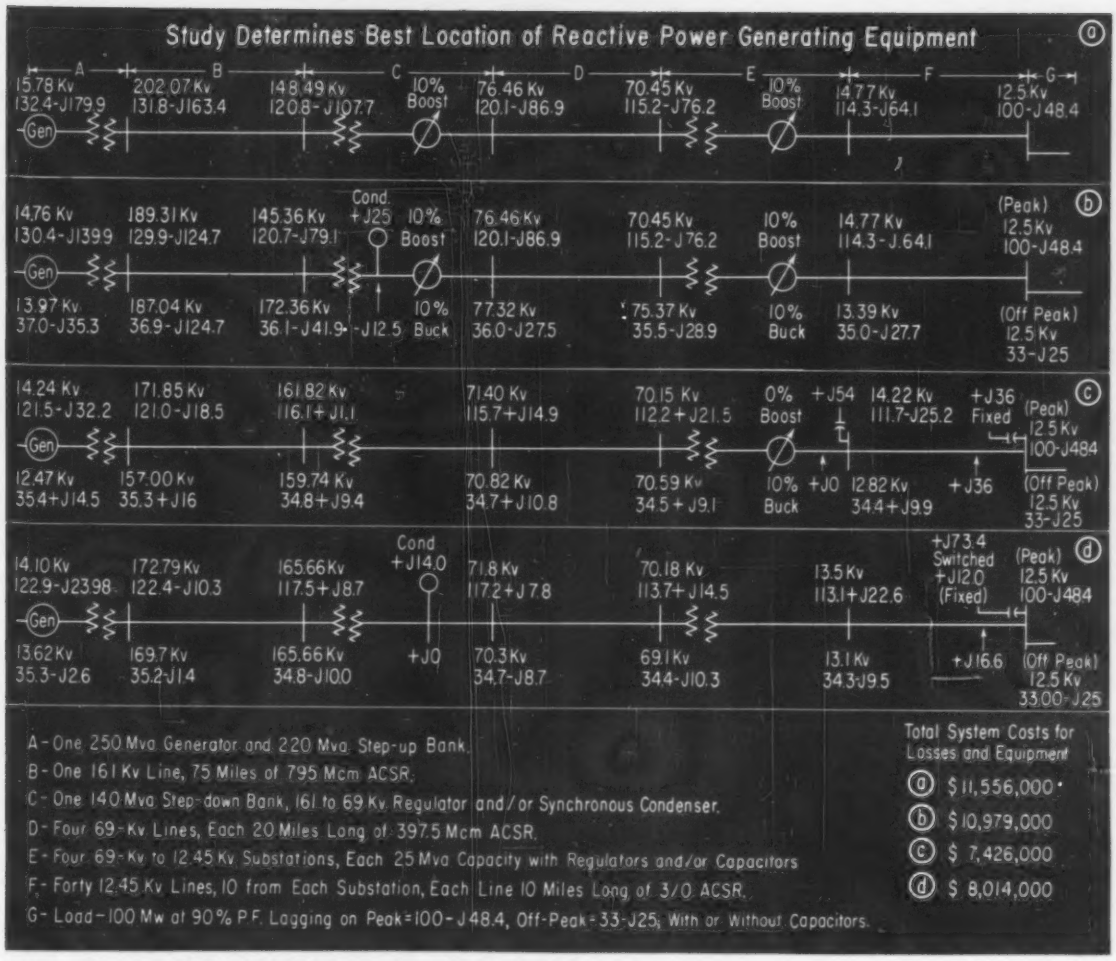


FIG 2—STUDY SHOWS effects of different locations of reactive generation: **a.** All by generating station; **b.** By generating station and synchronous condenser at main sub; **c.** By generating station, capacitors at distribution sub and lines; **d.** By generating station, synchronous condenser, fixed and switched capacitors

at all locations of 1,200,000 kvar in addition to a number at plants of large customers directly served.

TVA studies show that some synchronous condensers for stability and regulating effect are economical, and the ratio of TVA-owned synchronous condensers to total reactive capacity installed is now about 1 to 3 in some areas, and 1 to 5 in others. Large blocks of power are sold at .95 pf and higher.

Four plans are compared in the following studies of the kind and location of reactive power generating requirements. In all, the load to be carried is 100,000 kw at .90 pf, at the ends of 40 distribution lines, each ten miles long. Each of four distribution substations serve 25,000 kw to ten distribution lines and is fed by a subtransmission line of 69-kv 20 miles long. All four 69-kv lines come from a major high-voltage substation served by a 161-kv line 75 miles long from a generating station. A period of maximum loading is presumed, and losses are higher than system averages. The lines, loads, and substations simulate three different TVA areas.

Fig 2-a shows conditions that would obtain were all the reactive power generated by the generating station. This method, widely used in the past, requires that about double the reactive power be generated as in Fig 2-c.

Fig 2-b is like Fig 2-a, except that part of the reactive power is generated by a synchronous condenser at the major substation, and the quantity that must be generated is considerably reduced.

Fig 2-c resembles Fig 2-a, except that part of the reactive power is supplied by the generators and part by fixed distribution capacitors.

Fig 2-d is like Fig 2-c, except that some reactive power is supplied by a synchronous condenser and a large part by fixed and switched distribution capacitors.

The unit costs of the various components of reactive power generating equipment are actual 1950 costs to TVA. The cost of capacitors has declined, and those of generators and synchronous condensers have gone up, so that today conclusions might be different than these:

1. Although the generator cost per kvar is the lowest, it is not economical to generate all reactive power at that point because the amount would be almost double that

to be generated if it is generated in the most economical location.

2. The effect on transmission system losses of the location of the reactive power generating equipment may affect costs much more than the total cost of that equipment.

3. If the 161-kv line had been only 30 miles long and the 69-kv lines ten miles long, the proportion of reactive power that could be generated economically at the generating station would be greater.

Areas served at 22 and 33 kv were gradually changed to 46 or 69 kv. Studies resulted in TVA's decision to use 46 and 69 kv by reinsulating the lines and changing the substation transformers when they had to be changed for another reason. TVA has now only one subtransmission voltage in any area.

At present costs 69-kv lines are only about 10% per mile more than 46-kv lines when the same conductor is used, and carry 2¼ times as much with the same losses at the same voltage drop. Major high-voltage substations and district substations cost only 6% more at 69 kv than at 46 kv, making 69 kv the more economical subtransmission voltage in large areas. Changes of any part to 69 kv are gradual because of the large investment.

In 1940 the percentage of total subtransmission capacity of TVA's 69-kv lines was 23%, and the 46-kv lines' capacity 77% of the total. In 1957 the 69-kv lines were about 65% of the total. The capacity of 46-kv lines in the 46-kv area is kept as high as practicable by use of large conductors and capacitors.

One objective in raising subtransmission-line capacity was to permit increasing the size and decreasing the number of major high-voltage substations. In 1940 TVA had 31 such 161-kv substations having an average capacity of 25,200 kva. In 1957 it had 48 averaging 116,400 kva. Cost per kw drops rapidly as major substations expand.

Carry Larger Loads Economically

When no reactive power is transmitted, reliable 161-kv lines may carry quite large loads economically. Such lines are relayed for rapid reclosing and have few annual tripouts. Keeping conductors close to ground and installing two ground wires reduces tripouts, despite the TVA area's high isokeraunic level.

TVA has rapidly reclosing circuit breakers (generally 20-cycle reclosing) on every 161-kv transmission line in its high-voltage system, and each of these 135 lines is relayed with carrier controlled distance relays. Often such lines, 80 miles and longer and carrying 200 Mw or more, have tripped due to lightning, reclosed, and the system has remained stable. Board studies show an interruption of 60 cycles would result in a system breakup.

TVA measures resistance to ground of every steel tower and transmission structure. When a specific line is dispensable for 1 or 2 sec, because of the lines in the network connecting two points, TVA uses only the rapid reclosing on the lines; it does not install counterpoise. But when service depends on a line's continuous operation, it installs only the counterpoise necessary to maintain the one-to-four annual tripout rate for the specific isokeraunic level. TVA has continuous counterpoise only in a nine-mile section of two 161-kv lines.

Counterpoise is installed in many lines only on towers of the highest resistance, and usually does not extend more than 10 to 15% of any line's length. A line with counterpoise is protected to a 6, 8, 12, or 16 mv level, depending upon how much the system needs a particular line. Often this permits TVA to build a single circuit where otherwise two would be required.

A minimum of large-conductor transmission line with ultra-rapid reclosing and the least amount of counterpoise allows TVA to construct and operate low-cost major transmission lines with low losses and reliable service and at a low cost per kw. TVA does not expect to be able to reduce transmission losses much below 3½%. In fact, it seems likely that losses will fluctuate between 3½ and 4%.

Barring further economic inflation, TVA expects to reduce gradually the transmission investment per kw to about $35. It may consider very high-voltage transmission lines to obtain maximum generation where production costs are lowest. This may bring a higher ratio of transmission investment per kw. TVA, taking everything into consideration, will follow the most economical course. If total cost per kwhr delivered to customers can be decreased by increasing transmission costs, that is what TVA will do.

This article contains information also presented by the authors before the American Power Conference.

Cost of Equipment for Generating Reactive Power (In $1,000's)

	Added Transformer Cap. Above Minimum									
	Gen.	At Swyd.	At Major Sub.	At Dist. Sub.	Syn. Cond.	Sw. Cap. At Dist. Sub.	Fixed Cap. On Lines	Sw. Cap. On Dist. Lines	69 Kv Regul.	13 Kv Regul.	Total
Fig. 2-a	781	400	220	50	0	0	0	0	141	244	1836
Fig. 2-b	541	300	120	50	463	0	0	0	141	244	1859
Fig. 2-c	66	0	0	0	0	378[1]	288	0	0	244	976
Fig. 2-d	43	0	0	0	271	0	96	734[2]	0	0	1144

[1] 12-4500 kvar

[2] 5-300 kvar, 1-150 kvar, and 1-75 kvar capacitor banks on each 12.47 kv circuit (40 circuits total)

GE Develops High-Capacity Breakers

With an eye to future transmission voltages in the extra high voltage range, General Electric Co's switchgear department has unveiled a new line of high-capacity, outdoor air circuit breakers.

Designed for systems ranging from 115 kv through 460 kv, the new breakers utilize a pressurized interrupter principle involving modular units that provide all required voltage and capacity ratings.

C. E. Burke, general manager of the department, points out that the basic design module permits a building block approach to the application of transmission power circuit breakers. "Starting at 115 kv, 10,000 Mva interrupting capacity each additional interrupter column adds to the voltage and interrupting rating," he said. "Thus all conceivable transmission requirements are readily obtained through 460 kv, 33,000 Mva and even beyond."

Among the advantages listed by Burke for the new air breakers are 3-cycle interruption; ability to withstand maximum voltage recovery rate consistent with transmisison line faults and 75% less out-of-service time for routine interrupter inspection in comparison with oil power breakers.

Delivery time for the new breakers ranges from 11 months for the 115 and 138 kv units to 24 months for 345 and 460 kv units.

Adjustable Gain is Marketed by MIF

A recently developed adjustable crossarm gain is now being marketed by Malleable Iron Fittings Co, Pole Hardware Div, Branford, Conn. Designed for use between the poles and dimension crossarm of an H-frame structure, this new gain is reported to be completely adjustable from 7 in. minimum to 12 in. maximum high dimension crossarms. Its particular utility is the transfer of the heavier loads resulting from larger conductors and longer spans.

Shown are Messrs. W. R. Cover and Paul L. Lumnitzer of Pennsylvania Electric Co along with Messrs. D. R. Greig and J. A. Myrick, Development Engineers for Malleable Iron Fittings Co, observing final phases of tests at the MIF laboratory in Branford.

This new transition piece has teeth and ribs on both the pole and crossarm surfaces to help spread the load over a large area. The adjustable feature, which permits stocking only one gain, simplifies purchasing and handling for utilities using several sizes of transmission crossarms.

General Motors Develops Peaking and Reserve Plant

A 6,000-kw transportable Diesel powered peaking and reserve plant is now available from Electro-Motive Div of General Motors Corp. The new plant consists of three 2,000-kw generating units, each in its own steel, weather-proofed, sound-deadening housing, and one control unit with similar all-weather housing. Power is generated at 4 kv.

Electro-Motive engineers said that the cost of the plant is $85 per kw. Installation costs are estimated at $15 per kw. The plant can be controlled remotely and brought up to full power in 90 sec. Heat rate is about 11,000 Btu per kwhr. Delivery of the plant can be made in four to six months.

Skyworker Distributed by Asplundh Chipper Co.

Skyworker Div, Emhart Mfg. Co, Milford, Conn., has appointed Asplundh Chipper Co, Jenkintown, Pa., as national distributor of five Skyworker hydraulic aerial lifts.

Asplundh will sell and service the five models to the tree-trimming industry, utilities, and to state, county and municipal government. Skyworker will continue to sell directly to the general industrial, federal government and defense markets.

Orrin B. Maxwell is vice president in charge of Sales of Asplundh Chipper Co. He was formerly general sales manager for Skyworker.

(*More MN on page* 74)

These Features Reduce Maintenance, make...

GREATER PROTECTION

1 **COMPLETELY SEALED TANK** plus one-piece cover-clamping band provides protection against entrance of oxygen or foreign matter . . . prolongs oil life, reduces maintenance.

2 **INTERNALLY MOUNTED THYRITE*** by-pass resistor offers added surge protection right in the regulator itself. Internal bypass is protected from external damage.

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Unique electrical protection and optimum-life switching mean longer life, far less inspection and maintenance with G-E voltage regulators

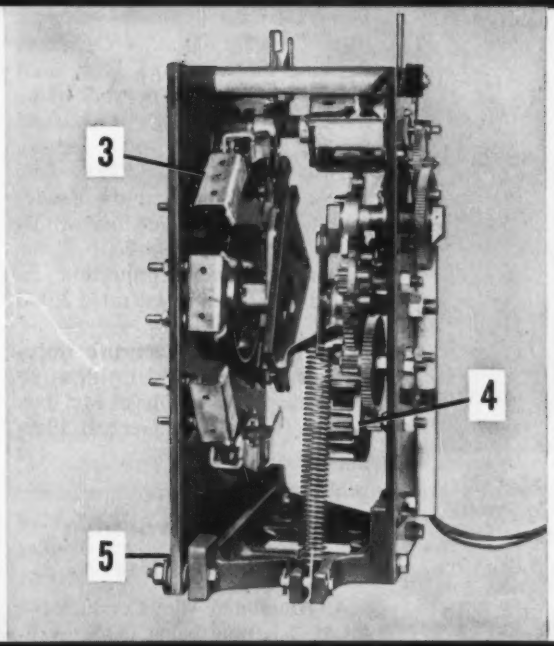
General Electric's ML-32 step regulator costs you less on the line because it requires less maintenance. You can apply this dependable regulator to your system, and not have to untank it for over twenty years of normal use. (Compare inspection recommendations of other regulators!) This unusually long life is made possible by such features as the completely sealed tank, electrostatic shielding, and optimum-life switching.

General Electric regulators cost less on the line because of the greatly reduced possibility of surge damage. This results from the application of an internally mounted Thyrite by-pass resistor. This superior protective material adds years to regulator life, and the device itself is not subject to damage in shipment or handling, as an external device would be.

Combined with longer life and superior protection, you get a regulator built with the highest industry classification of control accuracy—plus-or-minus 1 percent. This Class 1 Accuracy is standard on all ML-32 step regulators.

You'll want to know more about these cost-reducing features. Write to Section 423-27, General Electric Company, Schenectady, New York, or call your nearest Apparatus Sales Office or Agent.

.... General Electric Regulators Cost Less On The Line



LONGER LIFE

3 **NEW HEAVY-DUTY SWITCH** is used on higher-rated units to withstand your growing current requirements. Heavier contacts bring life of even highest-current regulators up to that of smaller, light-duty units.

4 **CONTROLLED SWITCHING SPEED,** provided by oil-immersed impeller on G-E optimum-life switch, extends switch life. The actions of the impeller and spring are coordinated to control switching speed, keep contact arcing to a minimum.

5 **ELECTROSTATIC SHIELDING** diverts electrostatic creepage paths . . . further reduces maintenance requirements. Tracking and carbon buildup are minimized. Result: Contacts can be completely eroded without deteriorating insulating strength of the oil to a hazardous value.

Progress Is Our Most Important Product

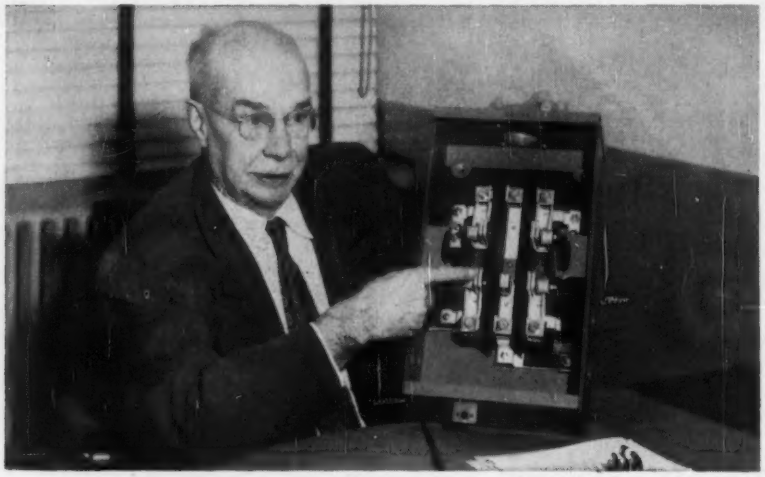
GENERAL ELECTRIC

Connectors, Switch Go on Mobile Display

An extensive station wagon tour has been planned to demonstrate new additions to the expanding line of Royal Electric Manufacturing Co, Inc, Chicago. The additions consist of Royal's new aluminum power connector and welding fittings, plus the entirely new Type RVL group operated switch.

The products will be shown from a display constructed in a Volkswagen. This mobile demonstration will be used throughout the tour which will cover over 25,000 miles. An 8-min sound slide film of Royal's aluminum power connector developments will be shown.

(Advertisement)



Here Is Something New In A 200 Amp. Socket that Mr. Charles Milbank, president of Milbank Manufacturing Co., would like for you to know more about. All adjustments are made from the front. The jaw pressure is applied after the meter is in position. No extra side clearances are required. It is designed for growing loads and available in either steel or aluminum; with manual or automatic by pass. What's more, it's priced right!

Why not write Mr. Milbank for a sample and more information? Address –

Milbank Manufacturing Company
1111 Virginia **Kansas City, Mo.**

You Can Bank on Milbank *Plants in Kansas City, Mo. & Kokomo, Indiana*

Two Feed Pumps Added to DP&L Expanded Station

Two more 12-stage, double-case, high-pressure, barrel-type boiler feed pumps will be added to the Indian River Power Station of Delaware Light & Power Co. The pumps will be built by DeLaval Steam Turbine Co, Trenton, N. J. Last year two similar De Laval pumps, were installed at Indian River, but the utility's expanding facilities require two additional pumps.

Each pump handles 375,000 lb per hr of 318 F feedwater at 2317 psig discharge and is driven by a 1500-hp motor at 3456 rpm through variable speed couplings.

Con Ed Installing Largest Network Transformers

Eight three-phase 2,500-kva network transformers, the largest yet built, are being installed by Consolidated Edison Co to supply 265/460Y-v service from 13,750Δ-v feeders to a new completely air-conditioned 30-story office building at 2 Broadway, New York.

The units are 25% higher in rating than the 2,000-kva network units installed at the Galbreath Building in New York City, until now the highest-rated network transformers on the utility's system and first to supply 265/460-v service.

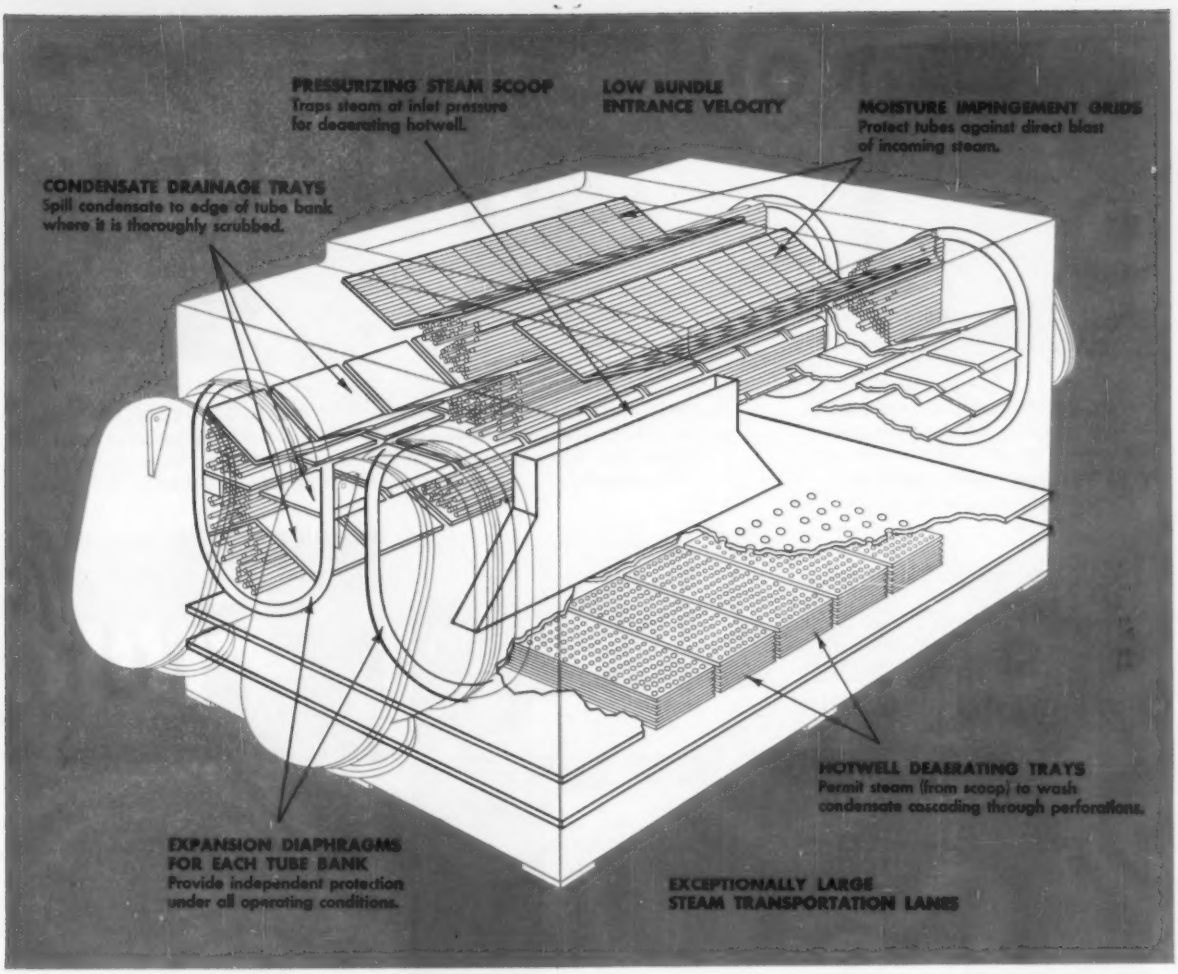
Four of the eight 2,500-kva units for the new installation are in sidewalk vaults. Remaining four will be installed on an upper floor of the building. Network protectors installed with the units are rated 3,000 amp.

Six of the eight network transformers were supplied by Pennsylvania Transformer Div of McGraw Edison Co; two by General Electric Co.

Kaiser AAAC Available For Commercial Use

All Aluminum Alloy Conductor—AAAC—is now being made available for general commercial use by Kaiser Aluminum & Chemical Sales, Inc, Chicago. Designed for overhead distribution systems, AAAC has the strength and electrical prop-

(*Continued on page* 78)


PRESSURIZING STEAM SCOOP
Traps steam at inlet pressure for deaerating hotwell.
LOW BUNDLE ENTRANCE VELOCITY
MOISTURE IMPINGEMENT GRIDS
Protect tubes against direct blast of incoming steam.
CONDENSATE DRAINAGE TRAYS
Spill condensate to edge of tube bank where it is thoroughly scrubbed.
HOTWELL DEAERATING TRAYS
Permit steam (from scoop) to wash condensate cascading through perforations.
EXPANSION DIAPHRAGMS FOR EACH TUBE BANK
Provide independent protection under all operating conditions.
EXCEPTIONALLY LARGE STEAM TRANSPORTATION LANES

Take an inside look at the exclusive "extras" in

ROSS SURFACE CONDENSERS

Nowhere in the industry . . . *nowhere in the world* . . . can you match the extra, exclusive values built into Ross Surface Condensers. The "inside story" is unfolded for you in the 110,000 sq. ft. unit shown here. Study it. Compare it. Draw your own conclusions.

American-Standard*, Ross Heat Exchanger Division has over 40 years' experience in the Surface Condenser field, backgrounded by a string of design "firsts" too long to list here. With a large new plant devoted exclusively to condensers and special heat transfer equipment, Ross is singularly qualified to build the equipment you need . . . any size, any number, for any set of conditions.

What are your requirements? Your inquiry will bring a nearby Ross engineer to your desk, or if you prefer, Condenser Bulletin 8.2K1 will be mailed with no strings attached.

American-Standard, Ross Heat Exchanger Division, Buffalo 5, N. Y. In Canada: American-Standard Products (Canada) Limited, Station D, Toronto, Ont.

*American-Standard and Standard ® are trademarks of American Radiator & Standard Sanitary Corporation.

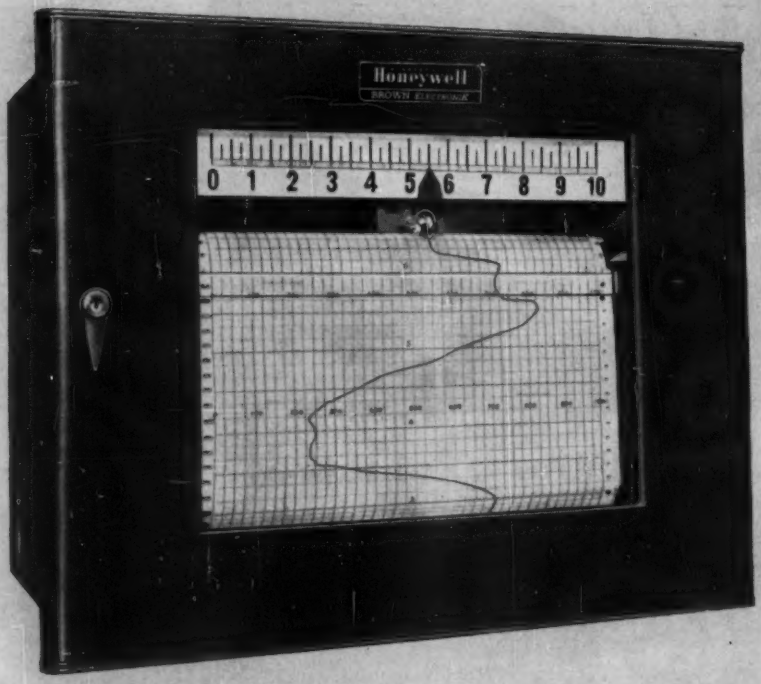
AMERICAN-Standard
ROSS HEAT EXCHANGER DIVISION

Circular Chart Recorder . . . Has large 28" indicating scale, is available with electric or pneumatic control. Extremely accurate and dependable.

Precision Indicator—Vertical Scale . . . Has drum-type, power-driven scale. Full scale travel in 12 or 4½ seconds.

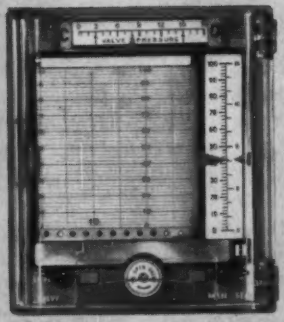
Circular Scale Controller . . . Scale is over 2½ feet long. Set point index rotates with scale for 12 o'clock control check. Available in all electric control forms.

From



Strip Chart Recorder—Single or Multiple Point . . . Records all types of variables. With either print wheel or pen. Choice of pen speeds and chart speeds.

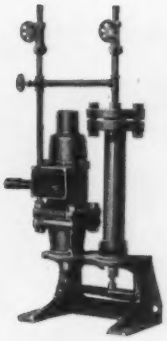
Diaphragm Control Valve—Series 800 . . . For heavy duty service. In standard sizes from 1 to 8-inch single seated—to 12-inch double seated.



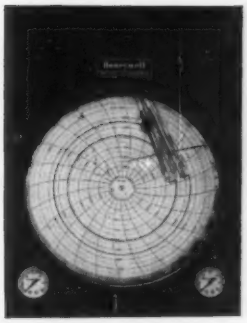
Tel-O-Set Miniature Recorder . . . Designed for graphic panels. Has automatic-manual unit, remote set-point adjustment and vertical indicating scale, and horizontal-scale valve pressure gage.

Differential Converter Transmitter . . . Highly responsive to rapid changes in flow, has continuously adjustable span requiring no change of parts over a 10-to-1 range.

Indicating Thermometer or Pressure Gage . . . Has 7½" eccentric type scale. Available with a variety of pressure sensing elements.



Mercury Meter Body—Electrical or mechanical, square root or evenly graduated.



Recording Controller . . . For temperature, pressure, flow, liquid level, etc. Wide choice of control systems. Available with electronic integration to totalize flow.

ONE Source...

instrumentation

...for your every need

Let Honeywell take care of *all* your instrumentation needs. From this one dependable source—the world's largest maker of automatic controls—choose exactly what you need, from a line of instruments as broad as your requirements.

Whatever you want to measure or control—temperature . . . pressure . . . conductivity . . . pH . . . flow . . . load and frequency—you'll find precisely the right instruments in Honeywell's complete line.

You can be sure that equipment suggested for your plant is recommended without bias.

With a complete line there's no need to over-sell or under-equip. And when you get all your instrumentation from a single source, you enjoy the important advantage of undivided responsibility by Honeywell for the complete installation.

Your nearby Honeywell field engineer will be glad to discuss your needs. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

H HONEYWELL

First in Controls

Here in a new substation just north of Tulsa, as in many other locations, the Public Service Company of Oklahoma uses C & D PlastiCell batteries as an always-dependable source of power for switchgear control. By opening and closing circuit breakers, operating pilot lights and control relays, C & D PlastiCell batteries help keep vital switchgear equipment on the job.

Just as the Public Service Co. of Oklahoma has found C & D PlastiCell batteries to be specifically designed and engineered for control service, you'll find they'll meet your every need for all control, switchgear and auxiliary power needs. In C & D PlastiCell batteries you get:

Dependable standby power (160 A.H.) is provided by this C & D 60-cell PlastiCell battery.

- **Long life** due to exclusive suspended and supported plate construction; extra-thick, triple insulated plates.
- **Low in-space cost** because plastic jars are lighter, break-resistant and require less space.

Write for descriptive literature on C & D PlastiCell batteries.

*Trademark

C&D BATTERIES, INC.
of Conshohocken, Pa. ... Attica, Ind.

Since 1906
Sales and Service Offices in Principal Cities from Coast to Coast

Manufacturers of Sure-Cap ® Industrial-Batteries • PLASTICELL and PLANTCAL ® Batteries for Communications, Control and Auxiliary Power • Producers of Autolay • Silicon Chargers

Kaiser AAAC

(*Continued from page* 74)

erties of ACSR (Aluminum Conductor Steel Reinforced), costs the same on a footage basis and yet offers many installation, upkeep, performance and economic advantages, according to the company.

The new solid or stranded conductor is available bare, covered, or insulated, in AWG sizes from No. 6 up to virtually any circular mill size required. AAAC is a high-strength, heat-treatable aluminum alloy with magnesium and silicon as the main alloying elements. Conductivity is between 52 and 53%, compared to the 52.3% composite conductivity for the common 6/1 strandings of ACSR. The product is released for general sale at no price premium.

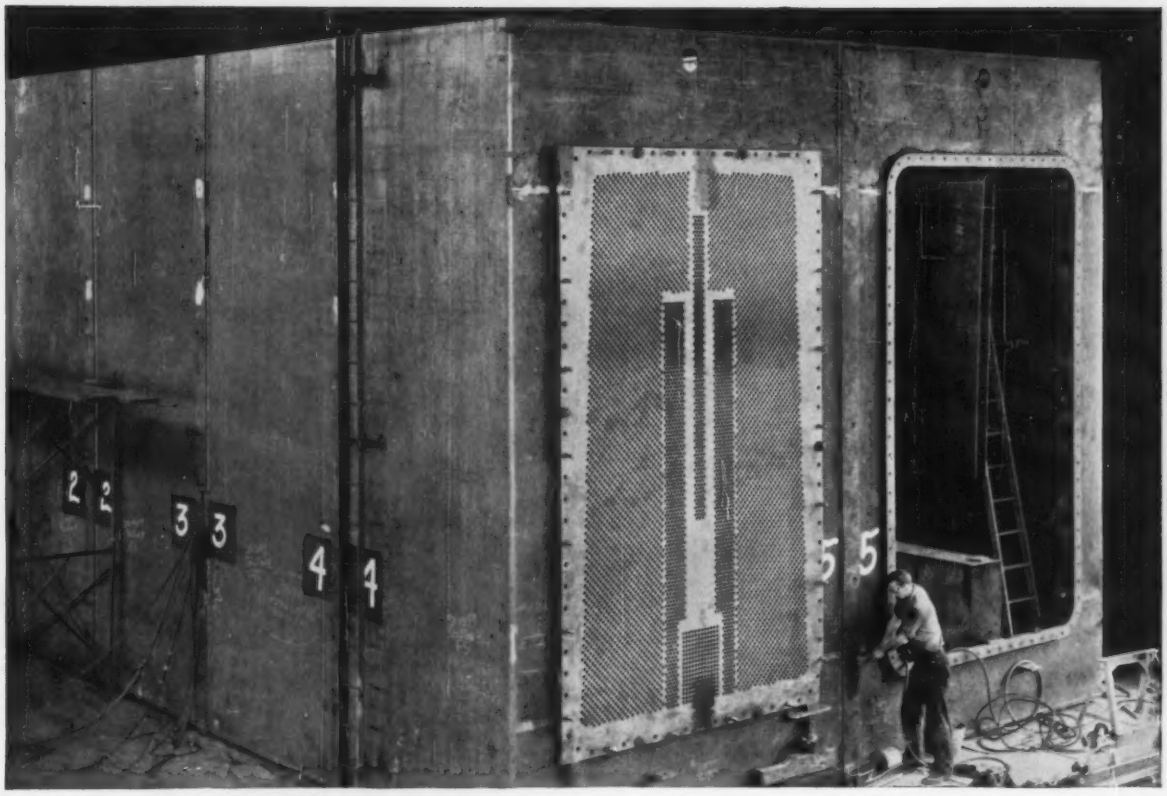
Eddystone Transformers Have Dual-Cooled System

Power transformers for the dual-cooled main bank are now being installed at Philadelphia Electric Co's Eddystone station. The installation will consist of two 200,000-kva Allis-Chalmers transformers manifolded to a common cooling system (EW, Aug. 6, 1956, p 154). This is said to be the first dual-cooled transformer system to be installed.

In this system one half of the Electro-Cooler units will normally serve one transformer. But valving will permit all cooling to be transferred to one transformer if the other must be deenergized. This arrangement enables either transformer to carry full generator output during a one-transformer outage.

Rectiflow Drive Developed

Rectiflow drive, a packaged adjustable-speed drive, has been developed by Westinghouse Electric Corp, Pittsburgh, Pa. The package consists of an a-c motor, a d-c motor, and semiconductor rectifiers. It affords continuously variable speed control over speed ranges of 1.5 to 1, 2 to 1, or 3 to 1; maximum speed is 1,690 rpm. All power requirements are supplied from normal a-c distribution systems.

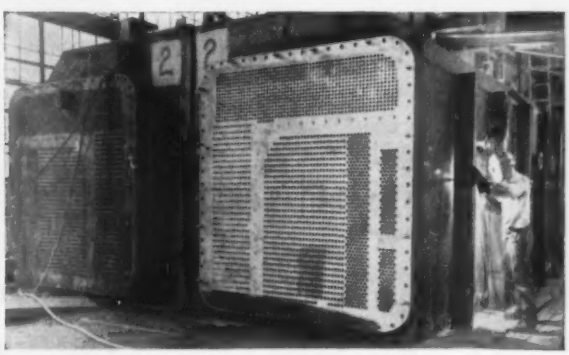


HERE'S ONE SHELL of this twin-shell, triple-lane unit just before shipment to Consolidated Edison's Astoria Station. It's designed to condense 1,600,000 lbs. steam/hr. at 1.87" Hg., with 244,000 gpm circulating water, and has 27,450 aluminum-brass tubes. Unit serves 335,000 kw turbine.

HUGE, SINGLE-PASS, 187,000 sq. ft. CONDENSER

... designed and built by C. H. Wheeler is now being installed at world's largest metropolitan utility

VICE-PRESIDENTS LEE YETTER and Roy Droescher, and Chief Engineer Paul Hamm are responsible for the design and construction of all Wheeler condensers. They work with engineers employed by C. H. Wheeler's customers, with turbine manufacturers' engineers and consulting engineers in BTU chasing.



TYPICAL REVERSE FLOW CONDENSER is this 35,000 sq. ft. unit for a Southern electric utility. Patented Reverse Flow feature permits flushing debris from tubes with only slight (and momentary) vacuum loss. Note low height to save head room, rectangular cross section to further utilize space for this Wheeler client.

C. H. Wheeler Mfg. Co.

19TH & LEHIGH AVENUE
PHILADELPHIA 32, PA.

Steam Condensers • Vacuum Equipment • Centrifugal, Axial & Mixed Flow Pumps • Marine Auxiliary Machinery • Nuclear Products

100% Tiger Brand. Both main feeders and distribution cables are Tiger Brand. The main feeders are 3-conductor, paper-insulated, lead-sheathed cables. Customer wrapped a fireproof tape over the lead sheath.

USS Tiger Brand Electrical Wire & Cable

A standard cable for every special job

- Asbestos Wire and Cable
- Mold Cured Portable Cord
- Shovel & Dredge Cable
- Paper & Lead Cable
- Varnished Cambric Cable
- Interlocked Armor Cable
- Special Purpose Wire & Cable
- Aerial, Underground and Submarine Cable

At Universal Atlas Cement Company . . .

They looked ahead to solve tomorrow's power problem

TWO OF THE LARGER CEMENT KILNS in the country —each 360 feet long by 11 feet in diameter—are busy turning out cement at Universal, Pennsylvania. It takes a lot of electric power to run this plant of Universal Atlas Cement Company. But power is one thing they have plenty of—now and for the foreseeable future.

A new distribution system, designed jointly by Universal Atlas and Duquesne Light Company, was installed in 1952. It not only can handle today's peak loads of 8,976 kw, but also can easily handle a 50% expansion in productive capacity and power demand.

A 60-foot drop between the outdoor substation and the plant distribution center presented the possibility of excessive oil migration to the bottom of the rise. Special fittings shown in this manhole permit easy checking of oil pressure to insure safety.

Tiger Brand Electrical Cable plays an important part in this look-ahead planning. Main power feed to the plant comes through 500-MCM, paper-insulated, lead-sheathed USS Tiger Brand Electrical Cable. All distribution cables are also Tiger Brand. At the time of installation, Universal Atlas applied a fireproof asbestos tape over the lead sheath. The installation has been trouble-free and is expected to last the life of the plant.

The tough jobs are the ones for which Tiger Brand Cables are made. Overhead, underground, underwater, anywhere that service is hard and specifications severe, Tiger Brand is the cable you need. Write for complete facts. Or call our nearest sales office. American Steel & Wire, General Offices: Cleveland 13, Ohio.

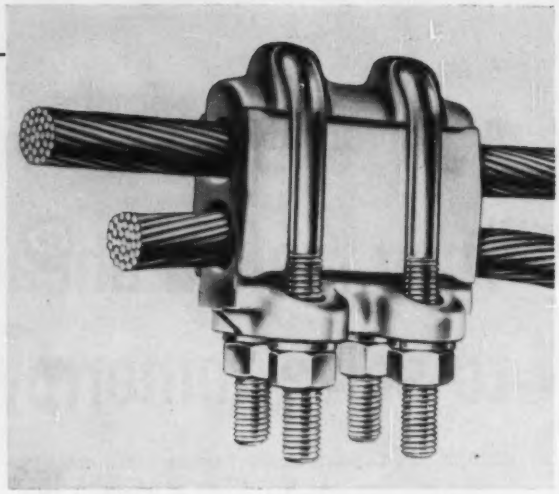
USS and Tiger Brand are trademarks

American Steel & Wire
Division of USS United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • Tennessee Coal & Iron Division, Fairfield, Ala., Southern Distributors
United States Steel Export Company, Distributors Abroad

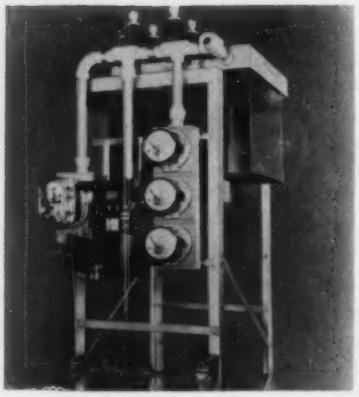
New Equipment

Heavy Duty Connector . . .



. . . covers range from No. 3/0 to 954 Mcm in three sizes. Type UP-R all-aluminum parallel groove clamp can be used with aluminum, copper, and ACSR in feeder, transmission, and primary distribution connections. Large contact area and sustained contact pressure make low resistance connections for heavy loads.

Special heat-treated captive U-bolts and tapered bell mouths minimize cold flow and cable chafing. Overlapping spacer tabs keep cable strands from splaying. Modified V groove creates wiping action and assures good electrical performance over connector range.
Burndy Corp, Norwalk, Conn.



Power Recloser . . .

. . . interrupts 8,000 amp at 14.4 kv or 12,000 amp at 4.8 kv. Rated 560 amp, it has minimum reclosing time of 2.5 to 3 cycles. Either side may be used for line or load. Designed for medium and small suburban substations, the type 560-PR has same mounting dimensions, operating and relaying mechanism, and accessories as 400-amp recloser.

Condenser type bushing may be eyebolt or four-bolt tongue type. Unit has provisions for two 600/5 or one 600/5 and one 1,200/5 bushing type current transformers. Other features are multiflow De-ion grid; 220-v motor closing mechanism; and adjusting air dashpot. Adjustable short circuit ground relay has sensitivity down to 40 amp. Ground trip sensitivity of 20 amp can be obtained, if necessary.
Westinghouse Electric Corp, Box 2099, Pittsburgh 30, Pa.

Electronic Fish Control . . .

. . . guides fish away from tailraces toward fish ladder, elevator, or traps, without injuring them. It has no moving parts and can be adjusted to compensate for different water velocities, conductivities, and size or species of fish by changing pulse rate, wave form, and output voltage. Electrode systems are designed to fit specific installation.

Other models are available to keep fish away from condensing water intakes, pumping installations, and hydroelectric diversions.
Electric Fish Screen Co, 1130 Poinsetta Pl, Hollywood 46, Cal.

Tubular Bus Clamp . . .

. . . permits wider spacing of support points. Spaced dual clamping provides support over longer stretch of bus. Clamp is high strength aluminum alloy, heat treated, with aluminum clamping bolts and galvanized steel mounting bolts, to accommodate either SIPS or EHIPS aluminum tubing.

Only one wrench is needed for installation. Mounting holes are slotted for rotation. Cap members can be rotated for rigid or slip-free mounting. Built-in spring prevents chattering. Cap screws are supplied for upright mounting; hardware for base mounting is available.
Anderson Electric Corp, Birmingham 1, Ala.

Compact Strip Recorder . . .

. . . has large storage capacity. One roll of paper provides full month's logging at speed of one inch per hr. Interchangeable gear trains are available for speed to 30 inches per hr. Free-swinging pointer touches pressure sensitive paper every two seconds, forming clean, continuous line of data. Rated accuracy is 2% of full scale. Rustak strip chart recorder measures 3⅝ x 5⅝ x 4⅛.
Rust Industrial Co, 14 Salmon St, Manchester, N. H.

Adjustable Speed Drive . . .

. . . has ±3% speed regulation and infinite speed range. Speed can be selected or changed with motor running. Absence of commutators and plug-in assemblies simplify maintenance. Unit permits slow speed starting and has smooth acceleration.

The VarEPack drive is available in ratings from one to 50 hp (and higher for some applications), with maximum speeds of 3,400, 1,700,

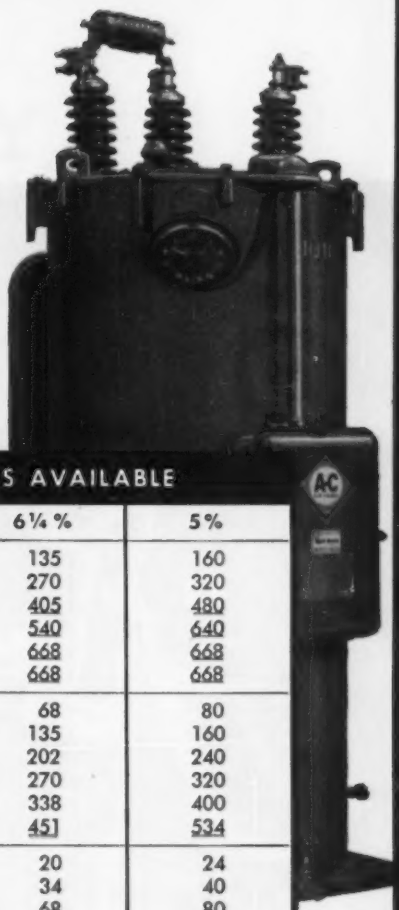
(*Continued on page* 86)

Allis-Chalmers—25 Years of Leadership in 5/8% Regulators

now... *Vari-Amp Ratings*

to 668 Amperes on Allis-Chalmers

distribution voltage regulators



RATING		RANGE AND CURRENT RATINGS AVAILABLE				
VOLTS	KVA	10%	8¾%	7½%	6¼%	5%
2,500	25.0	100	110	120	135	160
	50.0	200	220	240	270	320
	75.0	300	330	360	405	480
	100	400	440	480	540	640
	125	500	550	600	668	668
	167	668	668	668	668	668
5,000	25.0	50	55	60	68	80
	50.0	100	110	120	135	160
	75.0	150	165	180	202	240
	100	200	220	240	270	320
	125	250	275	300	338	400
	167	334	367	401	451	534
7,620	11.4	15	17	18	20	24
	19	25	28	30	34	40
	38.1	50	55	60	68	80
	57.2	75	83	90	102	120
	76.2	100	110	120	135	160
	114.3	150	165	180	203	240
	167	219/241	241/265	263/289	296/326	351/386
	250	328/361	361/397	394/434	443/487	525/578
13,800	34.5	25	28	30	34	40
	69.0	50	55	60	68	80
	138.0	100	110	120	135	160
14,400	36.0	25	28	30	34	40
	72.0	50	55	60	68	80
	144.0	100	110	120	135	160

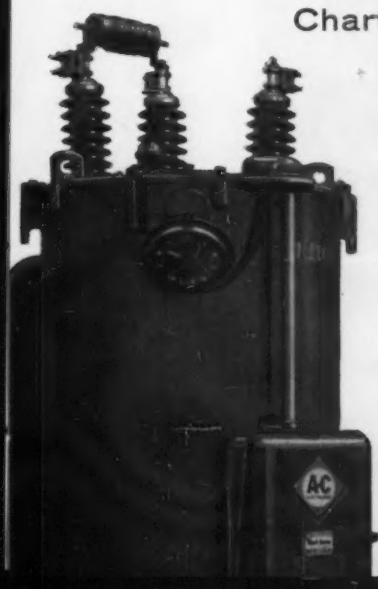


Chart shows ratings to 668 amperes with 21 new *Vari-Amp* ratings

Vari-Amp can now be used to increase regulator capacity (while decreasing range of regulation) to a maximum allowable current of 668 amperes or 160%. This new development results in increased applications for distribution regulators and further lowers the cost of regulation.

You now get as much as 50% increased kva capacity on 21 different ratings of Allis-Chalmers ⅝% step regulators.

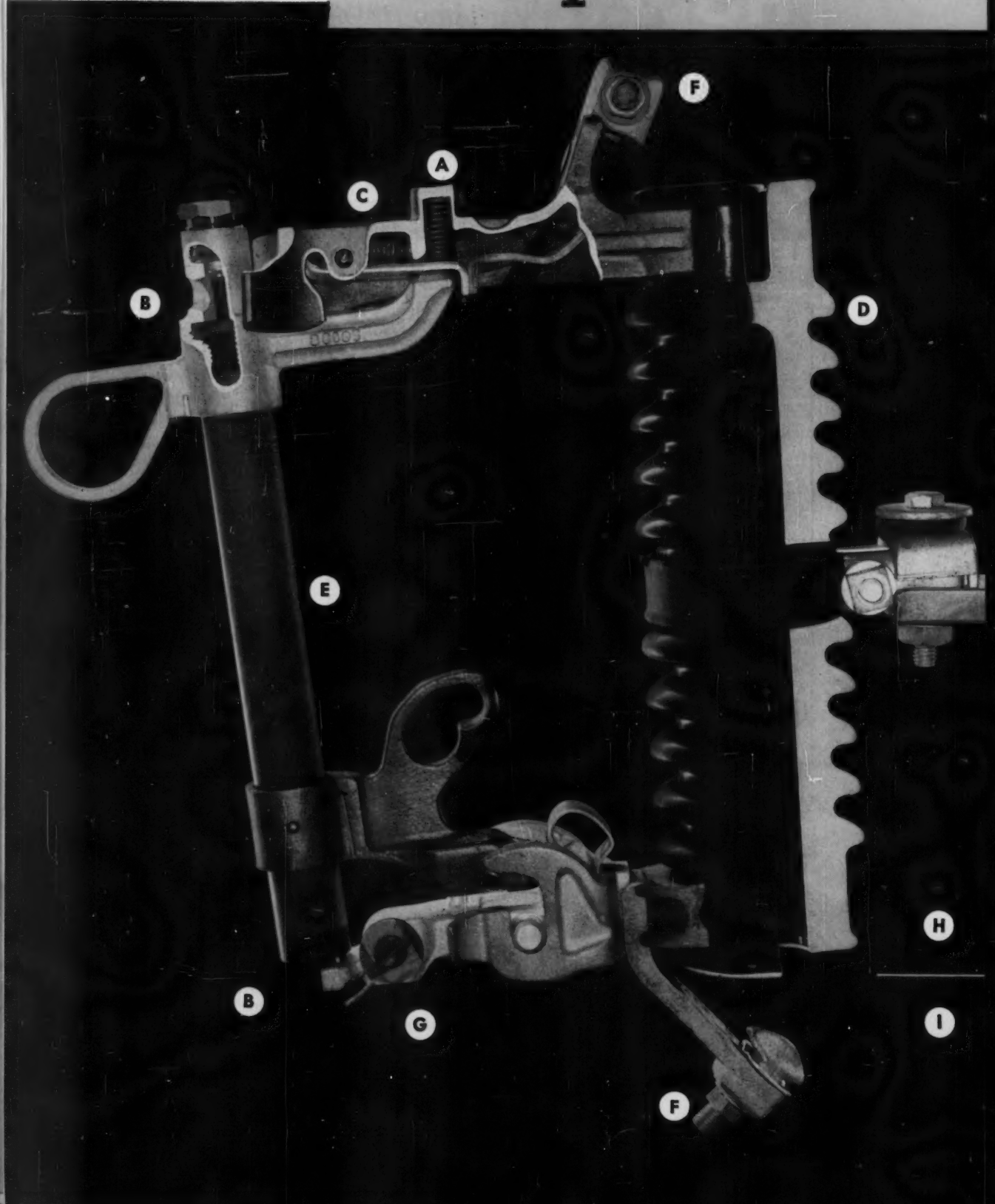
These new load-carrying capabilities have been tested in actual field service for four years and many of the new ratings are in stock for immediate shipment. Behind this announcement is the continuous development program that has maintained Allis-Chalmers design and operational leadership during the past 25 years.

For details, contact your nearby A-C office, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-5751

For full range fault protection...



specify KEARNEY Type "G" Cutouts

Extensive, rugged, field operating tests prove that the Kearney Type "G" Cutout provides full protection throughout the complete range of fault currents—without use of adaptors or gadgets.

Study the advanced features that make these extra heavy duty cutouts your most logical choice for line fusing, transformer and capacitor protection.

Ask your Kearney representative to explain fully why you can count on Kearney Type "G" Cutouts for superior construction, thorough dependability and unfailing protection.

Check These Advanced Features

- **A** Full Floating Contact—stainless steel spring absorbs upward thrust, maintains contact pressure until arc is extinguished.
- **B** Gas Vents—double vent action minimizes internal gas pressure.
- **C** Horizontal Stainless Steel Spring—helps absorb recoil during fault interruption, takes shock when closing cartridge.
- **D** Insulator—designed for strength and lightness, barrier prevents internal leakage.
- **E** Cartridge—½" bore assures positive interruption of low faults; extra strength tube withstands pressure of high currents; accepts universal fuse links; no need for adaptors and other gadgets.
- **F** Terminals, Plated T-Lug Design—for use with all types of conductors.
- **G** Flipper—whip action provides 4" travel in separating blown fuse link.
- **H** All live parts non-ferrous or stainless steel.
- **I** Can be field or factory equipped with link break attachment.

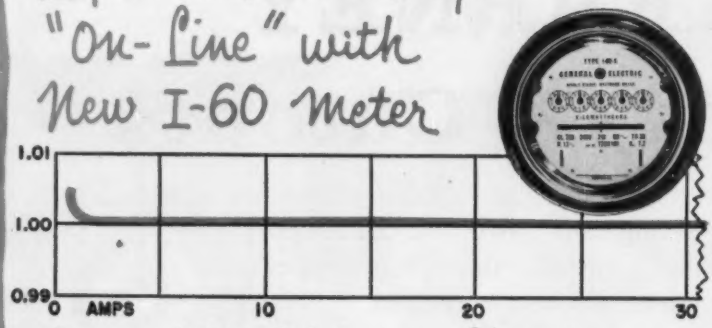
JAMES R. KEARNEY CORPORATION • 4224-42 Clayton Avenue • St. Louis 10, Mo.

FOR BETTER CONSTRUCTION—SAFER MAINTENANCE

Specify Kearney Products

Plants at: **ST. LOUIS • FAYETTEVILLE, ARKANSAS • SHENANDOAH & CLARINDA, IOWA • GUELPH, ONTARIO, CANADA**

Light-load Accuracy "On-Line" with New I-60 Meter



General Electric's new Class 200 I-60 meter offers truly outstanding accuracy at light loads... equal to or better than any Class 100 meter. Your G-E salesman will show you why.

(628-14)

GENERAL ELECTRIC

Properly Designed
COOLING RADIATORS

TRANSFORMER TANKS to Specification

Shaw-Perkins Cooling Radiators are available in a complete range of sizes and models, to give any make and capacity of transformer all the efficiencies of thermosiphon self-cooling. They feature full length oval tubes for optimum heat dissipation, free flow. Flanges, elbows, valves, and other accessories available for any mounting condition.

Transformer tanks, another specialized Shaw-Perkins service to the industry, are engineered and built to customer specification, from pole mounted distribution types to power transformer types up to 3750 KVA.

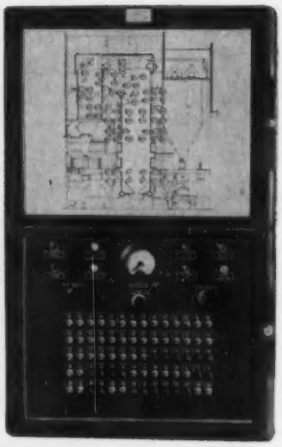
SHAW-PERKINS MANUFACTURING COMPANY
201 East Carson St. · Pittsburgh 19, Pa.

Adjustable Speed Drive . . .

(*Continued from page* 82)

and 1,130 rpm. Standard drives are 208/220/440 and 550 v, 3-phase, 60 cps. Two-phase drivers are available as special.

Electric Products Co, 1725 Clarkstone Rd, Cleveland 12, Ohio



Soot Blowing System . . .

. . . provides automatic sequence or individual unit operation of soot blowers. Any number of blowers can be pre-set, by individual toggle switches. System permits reversing of blower at any point in its cycle, switching automatically from automatic sequential to individual unit operation, and provides instant warning of any malfunction. Program lights on master panel indicate which blower is operating.

Model EC-120 handles up to 120 blowers; EC-60 takes 60 blowers; and EC-45 is for 45 or less blowers. System can be used for air, steam, or combination blowing medium, but only with electric drive systems.

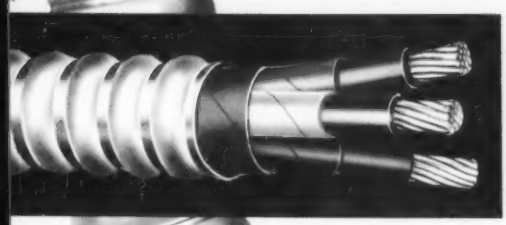
Copes-Vulcan Div, Blaw-Knox Co, Erie, Pa.

Step Voltage Regulator . . .

. . . has completely sealed tank and heavier duty tap changer in redesigned model. Switch is designed for growing current requirements and longer contact life with fewer inspections. Tank is sealed with nitrile rubber and has one-piece clamping

(*Continued on page* 91)

TRIANGLE'S FLEXIBLE INTERLOCKED ARMOR CABLE



installs quickly, easily . . .

WITHOUT CONDUIT

- for new construction
- for changes in plant layout and expansion
- for rewiring older buildings

...Saves on Labor and Material Costs

Why not tear this out and file for future reference?

TRIANGLE CONDUIT & CABLE CO., INC.

New Brunswick, New Jersey

"It MUST Be Right!"

interlocked armor cable meets a variety of application needs

Triangle Interlocked Armor Cable is widely used for primary and secondary feeders in power distribution systems; for station auxiliaries and generator leads; and as station control cable. This cable can be trained and twisted around building columns, bends and obstructions, permitting the use of long continuous lengths.

types of installations

For new construction, Interlocked Armor Cable power systems have several advantages. They provide reliability of service at low installed cost, and accessibility for making future changes in plant layout. Adding circuits to meet increased power demands is a simple matter.

For plant expansion, changes in plant layout and modernization, these systems offer the same advantages. Furthermore, they are not limited by capacity of existing conduit, and are readily interconnected with older systems with terminals, taps, connectors, and other accessories now available.

For rewiring older buildings to take care of today's increased power loads, interlocked armor cable may be the only economical answer. To install "conventional" systems would be prohibitive in cost. With interlocked armor cable, new circuits or additional circuits may be pulled in around beams and other obstructions without structural changes.

insulations to match applications

TRIOZONE — Suitable for use in wet or dry locations with a maximum operating temperature of 85°C, this compound is a special development of Triangle, and has exceptional ozone resistance plus heat and moisture resisting qualities.

ASBESTOS-VARNISHED CAMBRIC — This insulation is a combination of asbestos, varnished cambric tape and asbestos in sandwich form. Exceptionally good for high ambient temperature operation, this insulation also possesses high dielectric strength.

VARNISHED CAMBRIC — Applied also in tape form, this high dielectric strength material operates at maximum temperature of 85°C. The impregnated tapes resist oils, greases and moisture.

tough built-in conduit-type protection with interlocked armor

STEEL

A galvanized steel tape, which resists corrosion, forms the outer covering for interlocked cables. The tapes are formed to lock, one convolution with another, so as to offer full mechanical protection.

ALUMINUM

Where added protection is desired against corrosion, the light metal aluminum can be used in tape form. It is applied in the same manner as the steel tapes.

advantages

SIMPLE and RAPID INSTALLATION — Design and layout time are greatly reduced. Triangle interlocked armor cable can be quickly installed in trays and racks.

EASY MAINTENANCE — Ready accessibility of cable in racks permits quick location of cable faults and circuit tracing. No venting or draining is necessary.

CIRCUIT FLEXIBILITY — Relatively little loss of material occurs in the rearrangement of an interlocked armor cable system. Changes in plant layout are handled with ease, even where new circuits are to be added.

LOWER TOTAL COST — Triangle interlocked armor cable systems mean lower total cost of materials and installation combined. Up to 50% savings in installation costs offset occasionally higher material costs.

REDUCED SPACE REQUIREMENTS — Space savings are achieved whether with one or several cables. However, the percentage of space saved is less for a greater number of cables.

REDUCED WEIGHT — Weight saving by the use of light-weight aluminum Triangle interlocked armor and aluminum components is reflected in lower installation cost due to ease of handling.

Triangle Interlocked Armor Cables

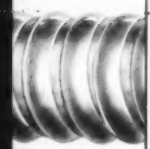
TRIOZONE INSULATION — 3 CONDUCTOR*

0-600 VOLTS					4001-5000 VOLTS				
Size AWG or MCM	Thickness Triozone Insul. 64ths Inches	Approx. Diameter Under Armor	Approx. Outside Diameter (inches)	Approx. Ship. Wt. Per 1000 ft.	Size AWG or MCM	Thickness Triozone Insul. 64ths Inches	Approx. Diameter Under Armor	Approx. Outside Diameter (inches)	Approx. Ship. Wt. Per 1000 ft.
8	4	.710	1.030	500	8	10	1.120	1.440	1009
6	4	.750	1.070	635	6	10	1.205	1.525	1179
4	4	.995	1.315	848	4	10	1.310	1.630	1429
2	4	1.025	1.345	1170	2	10	1.440	1.760	1913
1	5	1.180	1.500	1416	1	10	1.505	1.825	2171
1/0	5	1.266	1.586	1678	1/0	10	1.610	1.930	2475
2/0	5	1.368	1.688	2011	2/0	10	1.710	2.030	2849
3/0	5	1.478	1.798	2514	3/0	10	1.825	2.145	3700
4/0	5	1.605	1.925	3027	4/0	10	1.950	2.270	3847
250	6	1.776	2.096	3542	250	11	2.120	2.440	4461
300	6	1.895	2.215	4091	300	11	2.240	2.560	5077
350	6	2.005	2.325	4639	350	11	2.350	2.670	5692
400	6	2.102	2.422	5191	400	11	2.450	2.770	6273
500	6	2.290	2.610	6290	500	11	2.635	2.955	7468
750	7	2.735	3.060	9072	—	—	—	—	—

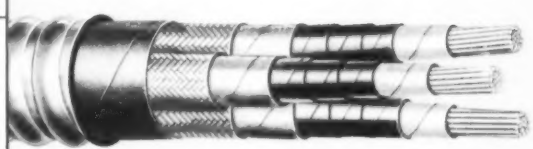
VARNISHED CAMBRIC INSULATION TRIOSEAL COVER — 3 CONDUCTOR*

0-600 VOLTS						4001-5000 VOLTS				
Size AWG	Insul. Thick. 64th In.	Sheath Thick. Inches	Dia. Under Armor Inches	Dia. Over Armor Inches	Ship. Wt. Lbs. Per 1000 ft.	Insul. Thick. 64th In.	Sheath Thick. Inches	Dia. Under Armor Inches	Dia. Over Armor Inches	Ship. Wt. Lbs. Per 1000 ft.
8	3	.060	.621	.941	618	6	.080	.905	1.225	1050
6	4	.060	.796	1.116	752	6	.080	.987	1.307	1375
4	4	.080	.987	1.204	1233	6	.080	1.090	1.410	1782
2	4	.080	1.117	1.307	1609	6	.095	1.250	1.570	2044
1	5	.095	1.285	1.437	2018	6	.095	1.337	1.657	2263
1/0	5	.095	1.372	1.605	2441	6	.095	1.423	1.743	2628
2/0	5	.095	1.473	1.692	2767	6	.095	1.525	1.845	2984
3/0	5	.095	1.583	1.793	3517	6	.095	1.635	1.955	3495

ASBESTOS-VARNISHED CAMBRIC INSULATION ASBESTOS BRAID — 3 CONDUCTOR*



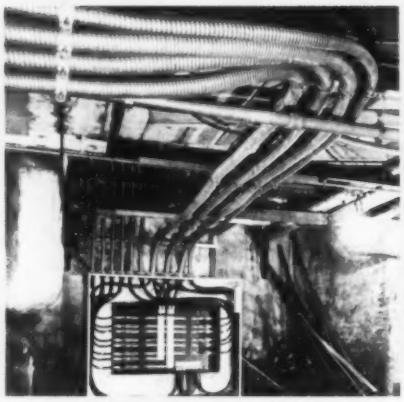
0-600 VOLTS					4001-5000 VOLTS			
Size AWG	Insul. Thick. Mils	Dia. Under Armor Inches	Dia. Over Armor Inches	Ship. Wt. Lbs. Per 1000 ft.	Insul. Thick. Mils	Dia. Under Armor Inches	Dia. Over Armor Inches	Ship. Wt. Lbs. Per 1000 ft.
4	65	1.058	1.378	1388	160	1.464	1.784	1847
2	65	1.188	1.508	1875	160	1.594	1.914	2231
1	80	1.318	1.638	2246	170	1.680	2.000	2563
1/0	80	1.406	1.726	2621	170	1.769	2.089	2978
2/0	80	1.505	1.825	3047	170	1.868	2.188	3378
3/0	80	1.616	1.936	3563	170	1.979	2.299	3895
4/0	80	1.741	2.061	4185	170	2.104	2.424	4548
250	105	1.990	2.310	4951	185	2.300	2.620	5319
450	105	2.415	2.735	7833	—	—	—	—



*Other voltage ranges and standard constructions are available

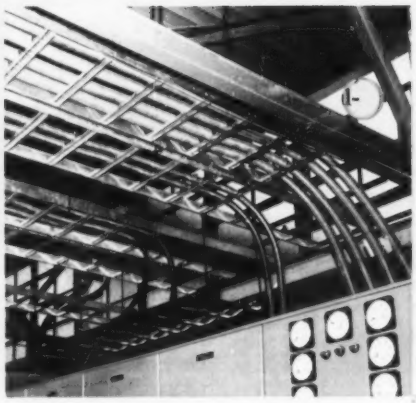
Why not tear this out and file for future reference?

TYPICAL INSTALLATIONS



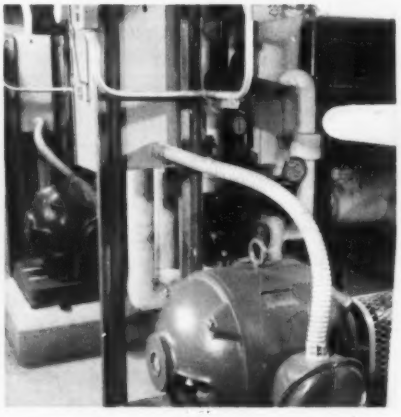
Because of its flexibility, interlocked armor cable provides a quick, economical way to install new circuits in an old building.

New cables can be added at anytime the electrical load increases and the need for additional capacity occurs.

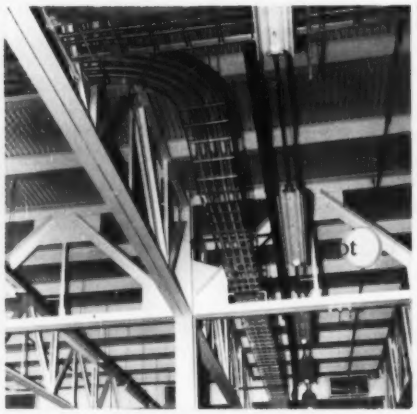


Multiple conductor control cable circuits are always accessible and easy to relocate.

Feeders to main power panels and load center sub-stations can be installed in long, unbroken runs without pull boxes and splices.



Interlocked armor cable speeds connections to motors and rearrangement of machines when equipment changes are necessary.



Installed in racks or trays, interlocked armor cables can be trained easily around corners and over beams.

MAIL THIS CARD TODAY

Triangle Conduit & Cable Co., Inc.
Triangle and Jersey Avenues
New Brunswick, New Jersey

Please send me more information on Triangle Interlocked Armor Cable ☐ I am also interested in receiving technical data on:

- ☐ Control Cable
- ☐ Varnished Cambric Cable
- ☐ Rubber Insulated-Trioprene (Neoprene) Covered Power Cables
- ☐ Street Lighting Cable
- ☐ Asbestos Insulated Cable
- ☐ Others, specify

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Company_____

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*Also Re-distribution Centers

TRIANGLE CONDUIT & CABLE CO., INC.
New Brunswick, New Jersey

"It MUST Be Right!"

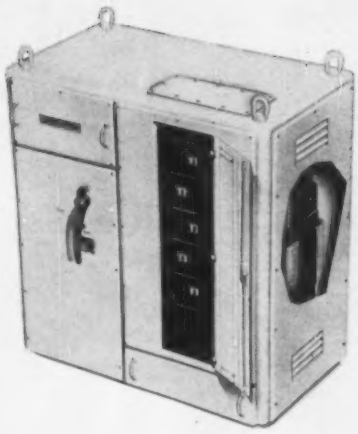
Bulletin IA-10 Printed in U.S.A.

Step Voltage Regulator . . .

(*Continued from page 86*)

bands on tank and manhole cover to exclude dust and moisture. Electrostatic shielding prevents formation of creepage paths along insulation.

General Electric Co, Schenectady 5, N. Y.



Dry-Type Power Center . . .

. . . is small, light, and quiet. Designated Type DT-3, it is available in 2.5- and 5-kv classes in 3-phase power ratings from 45 to 300 kva. Voltages on low side are 600, 480, 240, and 120 v.

Unit length is reduced from 91 to 67 in. In larger ratings, height is cut 15 in. Unit has air insulated, 3-phase load break switch, with or without fuses. Either top or bottom entrance is possible. The 45-kv BIL switch has Class A rating of 600-amp load current for 500 operations or Class B rating of 6,000 amp for 100 operations. Group III insulation permits 150-deg. C rise.

Westinghouse Electric Corp, Box 2099, Pittsburg 30, Pa.

More New Products

MEK-2128 low point **load control** is a current sensitive relay designed for a-c circuit operation to detect loss of load and to "fail-safe" on undercurrent.—Machinery Electrification Inc, 56 Hudson St, Northboro, Mass.

One-man operated **Power Kart** picks up cable reels up to 96-in diam and is available in capacities of 10,000, 14,000 and 20,000 lb. Compact unit has hydraulically controlled load arms which adjust to the width of reel.—Erickson Power Lift Trucks, Inc, 263 St. Anthony Blvd NE, Minneapolis 18, Minn.

Automatic **wave analyzer** for interpretation of line power faults provides analysis from 3 to 10,000 cps. Accuracy is within 1 cps from 3 to 50 cps, and 2% from 50 to 11,000 cps; amplitude accuracy is ± 5% of reading or ± 0.2% of full scale, whichever is larger.—Davies Laboratories, 10721 Hanna St, Beltsville, Md.

R Series **solenoid valve** combining large orfice capacity with high pressure differential is designed for use with air, water, oil and semi-corrosive media. Will handle temperatures from —65 to 180F ambient and —65 to 150F media.—Skinner Electric Valve Div, 105 Edgewood Ave, New Britain, Conn.

Service drop and aerial secondary **cables** rated at 75 C, 600 v, have Vulkene insulation, can withstand short circuits and occasional overloads. They have resistance to abrasion and impact and high insulation. Available with either copper or aluminum conductors.—General Electric Co, Bridgeport 2, Conn.

"Kover-Gard" plastic **molding** for covering ground wires, street lighting conductors and control wiring is compact, flexible, durable. Furnished in 8-ft lengths.—Fanner Mfg Co, Brookside Park, Cleveland 9, Ohio.

Self-contained, portable, **d-c ammeter** measures currents to 100 amp with 0.2% accuracy. Sensitivity is 50 mv.—Sensitive Research Instrument Corp, 310 Main St, New Rochelle, N. Y.

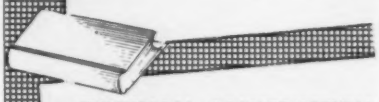
Truck-mounted **backhoe** for ¾ ton or larger truck has on-and-off feature which leaves truck free for other work when not needed for digging. —Ottawa Steel Division, Young Spring & Wire Corp, Ottawa, Kansas.

NATIONAL ELECTRICAL CODE HANDBOOK

Explains **how to handle wiring and installation jobs** in line with the 1956 National Electrical Code. Gives code rules in simple, clear language—tells WHAT they mean, HOW to apply them. Index lists code rules by job title for all types of electrical installation. Clear typesetting for quick, easy reference. **By A. L. Abbott. Revised by C. L. Smith, Elec. Field Engr., Nat'l Fire Protection Assn. 9th Ed., 642 pp., 394 illus., $8.00**

STANDARD HANDBOOK for ELECTRICAL ENGINEERS

Thousands of facts and figures, systems and measurements, methods and materials from all fields of electrical engineering. Covers everything from electric and magnetic circuits, regulators and reactors, and prime movers—to illumination, power system electrical equipment, and electronics and electron tubes. New information on transistor-nuclear power, dielectrics for capacitors, synthetic resins and plastics, automation, telemetering, etc. **Prepared by a Staff of Specialists: Editor-in-Chief: A. Knowlton, Consulting Ed., Electrical World, 2230 pp., profusely illus., $19.50.**



ELECTRICAL CONSTRUCTION COST MANUAL

Shows you how to make estimates of electrical construction work, developed through standard assemblies, unit costs of total material and labor units, and the addition of job factors, overhead, and profit. Step-by-step procedures for take-off, pricing, and summarizing the estimate. Useful graphs, charts, tables, drawings, etc. **By R. E. Johnson, President, Sturgeon Electric Co., 431 pp., illus., $10.00.**

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Just Published! A guide for the engineer taking on management relations and responsibilities. Chapters discuss production costs and their control; the basic financial transactions of a business enterprise—insurance, depreciation, taxes, power, labor, materials, etc.; the concepts of authority and responsibility; and the higher level decision-making process. **By Roger C. Heimer, Villanova Univ. 453 pp., $6.75.**

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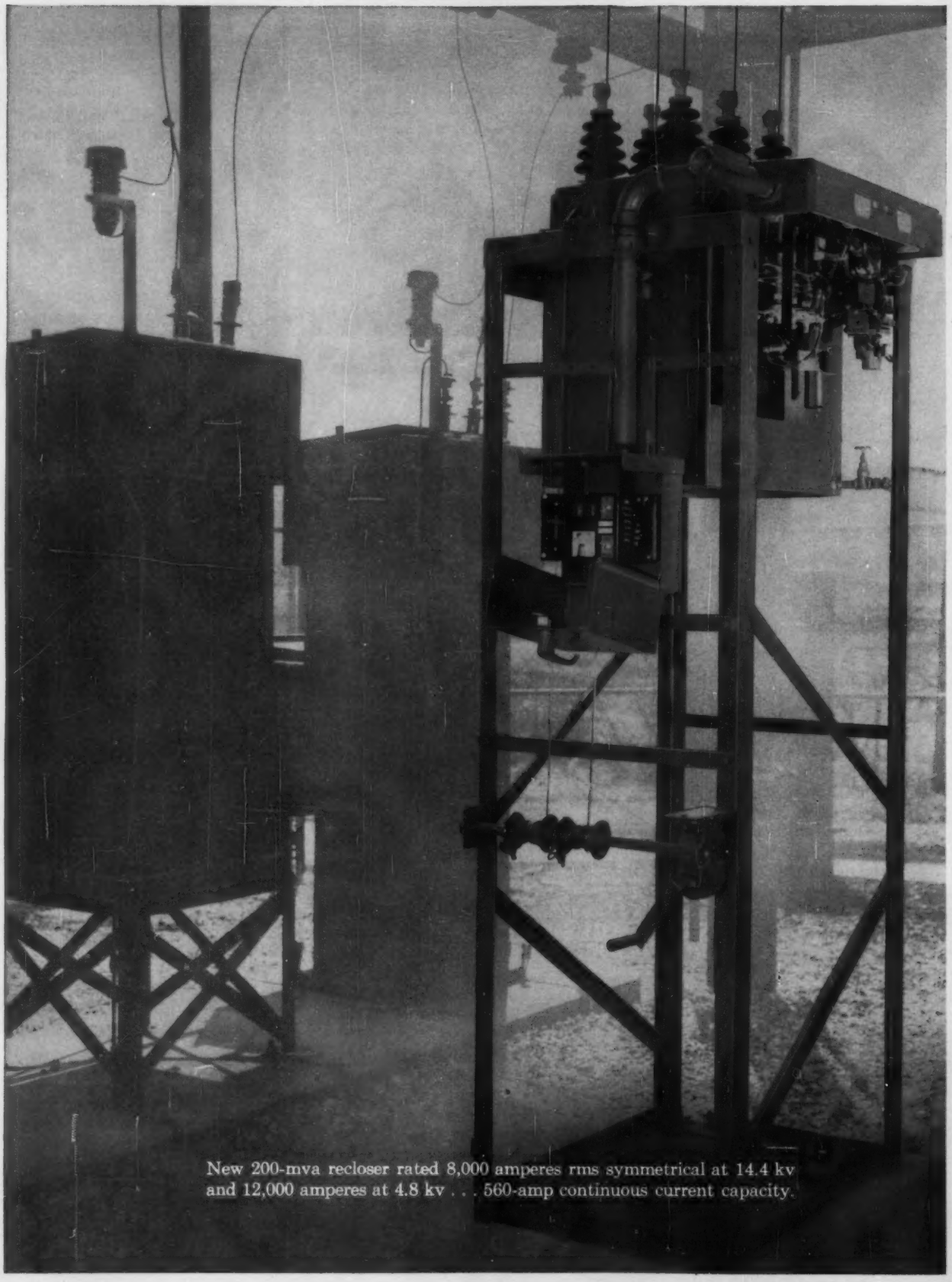


New 200-mva recloser rated 8,000 amperes rms symmetrical at 14.4 kv and 12,000 amperes at 4.8 kv . . . 560-amp continuous current capacity.

Now... distribution circuit protection for 1/2 the cost of power circuit breakers!

Another product of Plowback of Earnings into Research

The new Westinghouse 200-mva three-phase power recloser brings you all the time-proven performance you've long associated with our line of oil circuit breakers, plus 2½- to 3-cycle interruption. Designed for economical distribution system protection, the new recloser is rated at 560 amperes continuous, and up to 12,000-amp maximum interrupting capacity.

Many of our oil circuit breaker assemblies have been incorporated in the new Westinghouse recloser. These rugged components, combined by design engineers who've pioneered circuit interruption techniques, provide the outstanding buy in distribution circuit protection available today.

In addition to the breaker bushings, grids and operating mechanism described below, the new 560 PR recloser utilizes proven air dashpots from the DB industrial breaker . . . providing flexible and reliable relaying characteristics which are unaffected by temperature. 600/5 breaker-type bushing CT's are used. Standard, adjustable SC ground relays give ground tripping sensitivity of 30 amperes.

Conservative design permits overload capacity under emergency conditions without damage to equipment. Combined with 2½- to 3-cycle interruption, this means maximum utilization of your system capacity . . . with minimum danger of conductor burndown or damage.

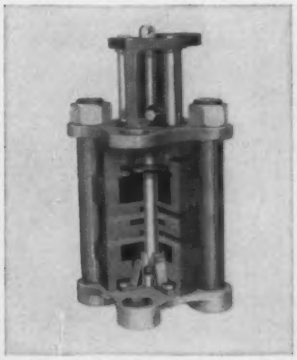
For complete information about the 560 PR recloser, call your Westinghouse sales engineer. Or, write Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa. Ask for Descriptive Bulletin 38-725.

J-60954

YOU CAN BE SURE...IF IT'S Westinghouse

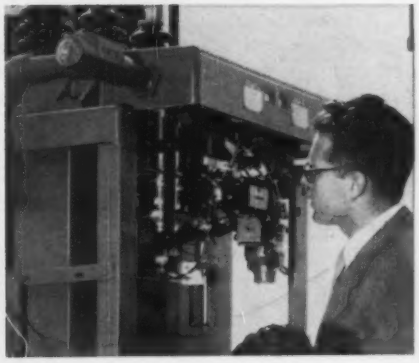
CONDENSER BUSHINGS

Standard Micarta® breaker condenser bushings are used for ruggedness to resist the high shocks of severe fault interruptions.



CIRCUIT BREAKER GRIDS

Unique high pressure current transfer roller of De-ion® grids provides high-speed 2½-cycle opening to prevent conductor damage and burndown.



NETWORK PROTECTOR MECHANISM

240-volt motor closing mechanism. This low-voltage control permits easy checking of your calibration curves and simplified maintenance. Mechanism provides 30-cycle high-speed reclosing.

OLD STORE had only 15 ft-candles over a very small area, resulting in poor display of merchandise and lower sales

NEW STORE boasts 80 ft-candle level, air conditioning, plenty of space. Result: more sales with bigger profits

Recipe for Brighter Cake Sales: Lighting, A.C.

W. L. STREICH, Commercial Sales Representative, Wisconsin Electric Power Co, Milwaukee, Wis.

Gardetto's Bakery in Milwaukee has found a new recipe for lighter, brighter cakes sales.

When the owner decided to expand recently, electrical modernization was to be a major feature of the new store. Space was available adjacent to the old retail outlet, and it was here that the new store was built. The old store became a work area, and it also was upgraded electrically.

The two main electrical features we put into the new store that did not exist in the old one were light conditioning and air conditioning. The lighting level of 15 ft-candles in the old store was boosted to 80 ft-candles in the new one. A combination of flush and hanging ceiling fixtures helped keep fresh, tempting merchandise well displayed. Air conditioning tended to keep customers in the store—and when they are in the store, they almost always buy.

Gardettos has reported that business has increased noticeably since the new store opened. Sales and profit are up, proving the new electrical features well worthwhile.

Important A.C. Developments Predicted

Air conditioners powerful enough to cool an entire house yet small enough to be carried under one arm, and capable of being installed in minutes, have been predicted by Bruce D. Henderson, vice president in charge of Westinghouse Electric Corp's air conditioning division.

"With a present market saturation in home air conditioning of something less than 2% the industry's growth potential appears almost unlimited," Henderson said. "Important new technical developments, which now appear to be well within our capabilities, will help the industry to realize much of this potential in the predictable future."

The Westinghouse executive said that future air conditioning units will provide not just filtered air, but electronically cleaned air from which 90% of all airborne impurities has been removed. The heating and cooling plants of the future will be silent and vibration-free.

"In order to manufacture units of the type described the industry will develop and put into production compressors no larger than a bowling ball," Mr. Henderson said. "We will have heat exchangers many times as efficient and far more compact than those in use today. The entire system will be miniaturized and manufactured by automatic methods."

Research Is the Key

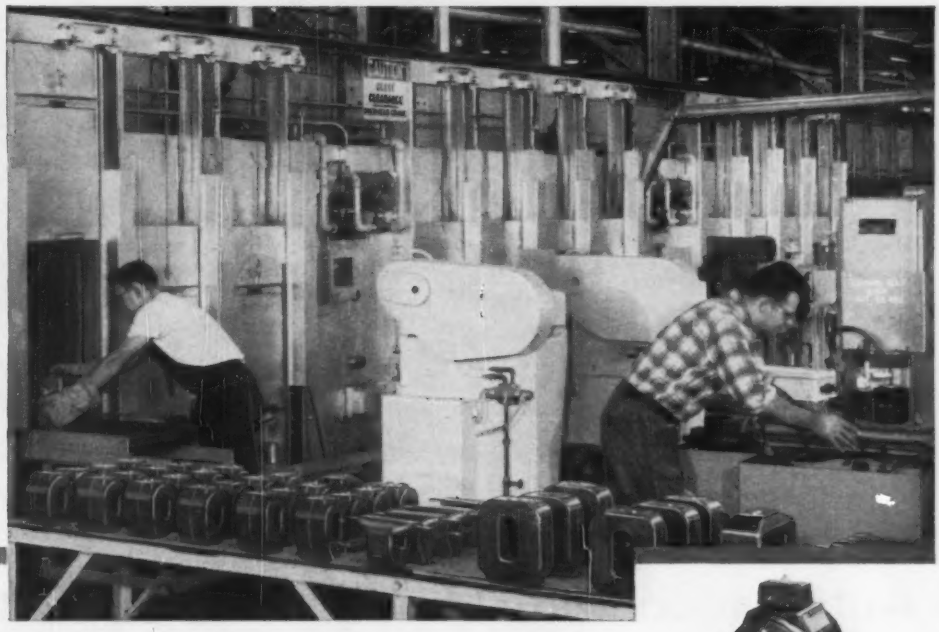
He pointed out that the industry has the knowhow to accomplish these things without any major technological innovations, but that manufacturers must be prepared to invest a substantial part of each sales dollar in research and development.

He said that any air conditioner manufacturer now spending less than 5% of sales for research will be at a competitive disadvantage ten years from now.

NLB Statistics

The relighting campaign of the National Lighting Bureau has produced the following statistics: Some 168,000 fixture certifications with an average dollar value of approximately $20.00 each. Some 2,456 jobs have been certified for a total estimating load of 32,929.22 kw. The average installation has involved 68.44 fixtures and 13.4 kw.

(*More Selling on page* 96)



Close temperature control of new ovens assures perfect curing of casing.

Allis-Chalmers expands production capacity to meet fast-growing demand for

Instrument Transformers

Epoxy Resin Cast

Industry's quick recognition of the superior quality of Allis-Chalmers instrument transformers cast of epoxy resin created a demand that was outstripping supply. Now, new facilities at Allis-Chalmers double the previous production capacity.

No Maintenance — Easily Installed

Epoxy resin, virtually a miracle material, gives transformers complete protection — both electrical and mechanical — either outdoors or indoors.

Allis-Chalmers epoxy resin transformers:

1. Have excellent dielectric properties.
2. Can withstand wide temperature variations and severe mechanical shocks.
3. Are maintenance free . . . require no painting, resist solvents.
4. Can be installed in any position . . . quickly, easily.

A number of new type instrument transformers for various applications have been added to the line. Additional types are now under development. Your nearby Allis-Chalmers office will give you details, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

Type TWM — 600-volt, indoor-outdoor light duty metering transformer for 200 through 800-ampere use. Window — 1⅜" x 2¾"

Type LM — 600-volt, indoor switchboard tripping and indicating transformer for 200 through 800-ampere use. Cable mounted — window 2¼" dia.

Type BKM — 600-volt, indoor-outdoor heavy duty metering transformer for 2000 through 4000-ampere use. Window — 4¼" square.

Type BKAW — 15,000-volt, outdoor heavy duty metering transformer for 1200 through 5000-ampere use. Window — up to 8¾" dia.

ALLIS-CHALMERS

A3685

Belt conveyor to move materials . . .

replaces hand carried baskets as . . .

Automation Ends Shoe Production Bottlenecks

THOMAS BALLOTS, Industrial Sales Engineer, Pennsylvania Power & Light Co, Hazelton, Pa.

An ingenious belt conveyor system that's faster, improves inventory control, relieves bottlenecks and requires less manpower, has entered the stitching room of Skippy Footwear Corp, West Hazelton, Pa. As a result, production and employee earnings are up, cycle time on the conveyor has been reduced to 22 minutes, from the previous time of 29, and three material handlers are now doing other jobs.

The operation is now smoother. Work on several shoe styles can be performed simultaneously without confusion. Also prompt delivery on customer orders has been attained. Prior to the conveyor installation, all material movement had been carried out manually and often haphazardly.

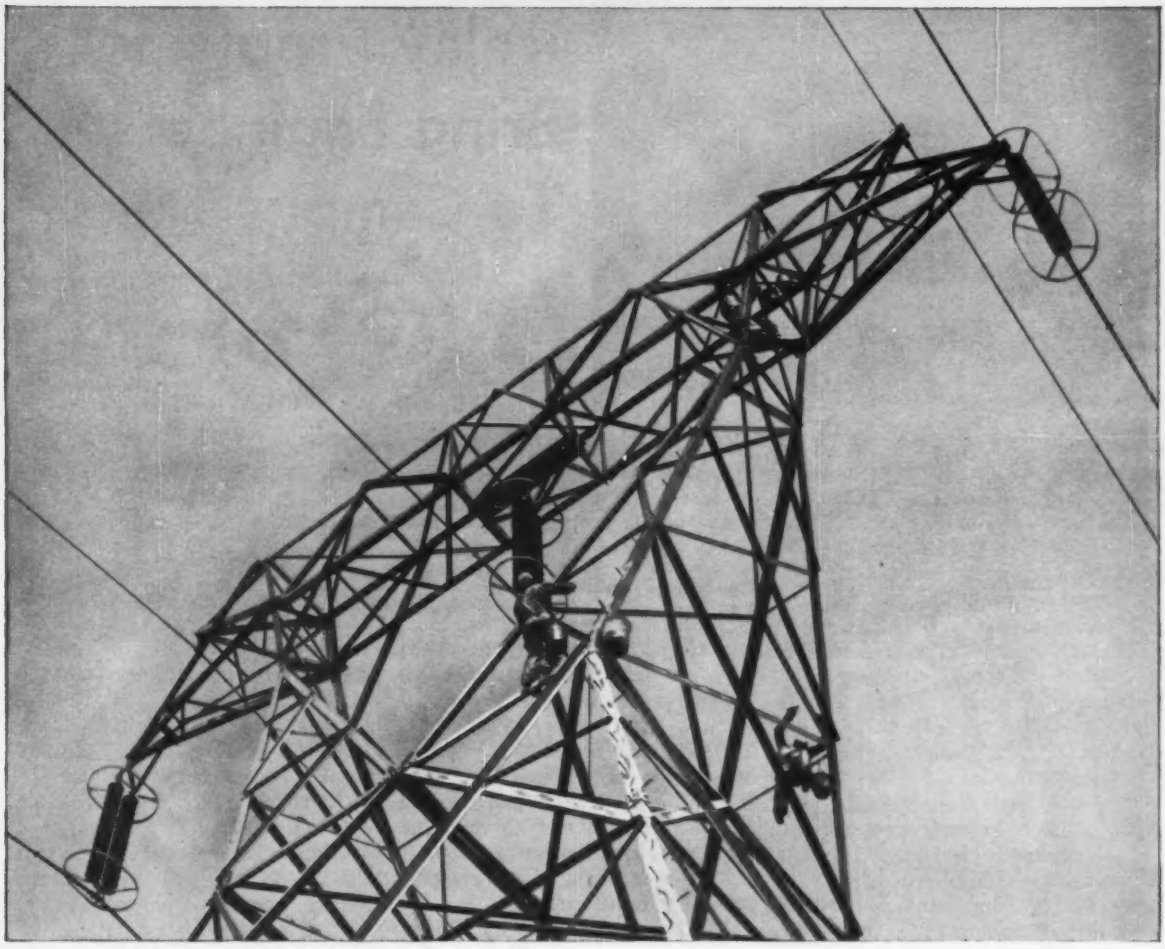
The heart of the system is the belt conveyor set up between two parallel rows of sewing machines and the other specialized stitching equipment required to perform the various operations on the shoe "uppers." Pieces of equipment performing the same operation are grouped together and assigned a station number. Pre-cut shoe components are then placed in separate metal "boats" and assigned station numbers showing type and sequence of operations to be performed. As the boat progresses along the line, it is intercepted at the proper station.

Torque Selector Control Reduces Drill Breakage

WILLIAM F. DOHERTY, Industrial Engineer Union Electric Co, St Louis, Mo.

Sensitorque feed control applied to a standard drill press at the Merit Specialties Co plant in St Louis has virtually eliminated the drill breakage experienced with manual operation. Torque applied to the drill can be pre-set to a value less than that required to break the drill. Another factor in the breakage reduction is elimination of the practice of "backing off" the drill to prevent work-hardening of the work piece. Other results are faster production and a better surface.

The feed control device varies the rate of feed so that a constant torque is applied. When a hard spot is contacted, feed continues at a reduced rate. The control operates from the value of line current drawn by the drill motor.



How much does it cost to paint a tower?

That's a difficult question to answer, for much depends upon the size of the tower, and its location. But whatever the figure, it adds up to a major expense when rust-drip from tower bolts makes premature painting necessary.

It's now possible to obtain bolts which resist corrosion even longer than the tower members. These bolts are coated with Bethalume—Bethlehem's new hot-dip aluminum coating. Their cost? Just slightly more than ordinary tower bolts.

The Bethalume coating enables fasteners to resist corrosive atmospheres because it arms the base steel with a durable, uniform layer of aluminum. The coating is applied by the hot-dip process, and in equal thicknesses, outlasts ordinary protective coatings in practically every corrosive atmosphere. What's more, the coated threads are relatively clean and smooth-fitting.

If you would like to know more about Bethalume-coated fasteners, and how they can hold your painting costs to the minimum, just get in touch with the nearest Bethlehem office.

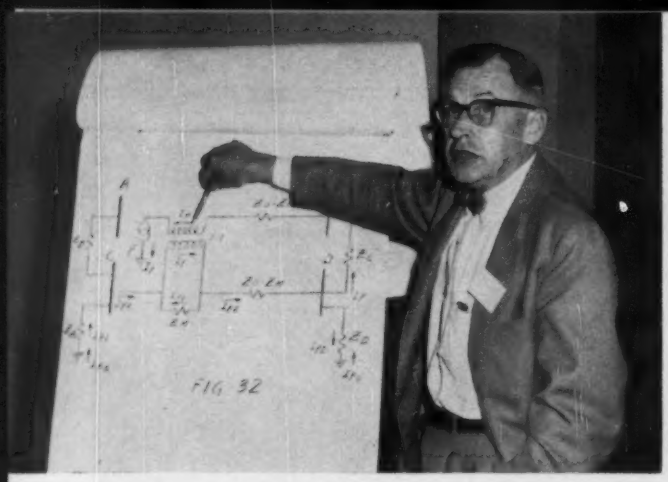
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

Relay Problems Bring Engineers To Campus Talks



A. J. SHAFER, Wisconsin Power & Light Co, explains method of solving relaying problems at Illinois Tech Conference

Relay engineers from a wide area gathered for the Illinois Institute of Technology's 1958 Relay Conference in Siegal Hall on IIT's campus April 24 and 25.

Discussing a unique relaying application, L. E. Landoll, Ohio Edison Co, said that when a 138-kv interconnection was established between his company's system and that of Columbus & Southern Ohio Electric Co, the phase angle between systems required a 60-Mva, 0-36-deg phase-angle and voltage regulator at Ohio Edison's East Springfield terminal. Relaying for this presented special problems.

Two relaying plans were considered. Plan 1 was for application of a current-balanced relay where the current in the exciting winding is balanced against that in the series winding. Plan 2 called for ratio differential relays where the current in all branches is balanced.

Plan 2 was selected because of the design difficulties of its alternative. Plan 1 would provide more sensitive protection under most conditions, but would require three current transformers insulated for 138 kv connected on the high side of the exciting winding. Although Plan 2 is less sensitive, the CT's are mounted near the neutral connection of the exciting winding and can be of lower insulation class.

Describing experience with fault-pressure and sudden-pressure relays on power transformers, W. F. Wolfe, Detroit Edison Co, reported that his company expects to equip more transformers with these relays as an added protection to the system in event of transformer failure. This protection is being planned although two false operations have been experienced. So far there have been no cases of proper operation of the relay because no transformers have failed where relays were installed.

Coupling Problems Cited

W. E. Rich, Westinghouse Electric Corp, said that the sudden-pressure relay is recommended, along with the differential relay, on suitable large power transformers. The harmonic-restraint relay can be applied, he said, where high-speed tripping is desired for faults within a transformer zone. This relay, he said, provides excellent coverage of faults during sub-synchronous operation of a transformer.

M. J. Lantz, Bonneville Power Administration, pointed out that coupling between transmission lines presents relay engineers with unique problems. He presented data showing that actual fault currents were sometimes ten times or greater than calculated ones where coupling between lines was neglected in the calculations. The problems proved particularly difficult when three parallel 230-kv lines were paralleled for part of their distance by a new 345-kv line. Calculations taking mutual impedances into consideration were made on the digital computer, and relaying based on calculated settings was satisfactory.

A. J. Shafer, Wisconsin Power & Light Co, said that for the less complicated setup of two parallel lines his organization has developed a method of representing mutual impedances on the dc board with a combination of batteries and resistances. He said that the utility had had difficulties similar to those reported by Lantz.

Relaying difficulties, their solution, and staged fault tests on a three-terminal 230-kv line were described by J. O. Grimm, Bureau of Reclamation.

Standard relaying was provided for this line. After too frequent loss of the line and accompanying instability difficulties, a series of staged fault tests were conducted to determine what to do about it. Findings from the tests resulted in:

1. Installation of a 230-kv breaker at Watertown terminal.

2. Three rather than five-cycle clearing time.

3. Changes at Watertown so that the 230-kv autotransformer is no longer essentially a part of the line.

4. Current and potential sources are separated from the line when the breaker opens.

5. Reach of second zone elements at Ft Randall terminal was increased about 10%.

6. To increase the probability of successful reclosing, reclosing time was raised from 25 to 30 cycles.

7. Ground relays were replaced with similar relays having instantaneous elements of lower current ranges.

Back-up protection for the 115-kv ring bus at the High Bridge plant of Northern States Power Co was described by K. K. Dols. Such protection for faults emanating from the 115-kv bus is particularly important because High Bridge represents 30% of the system's generating capability.

For this back-up protection, breakers and current transformers were available in the bus tie circuit breakers. The relays, a potential source and a separate dc source had to be added to provide complete back-up protection.

ALLEN-BRADLEY

new

BULLETIN 350 reversing drum switch

Styled by Brooks Stevens, internationally famous industrial designer.

- *MODERN IN APPEARANCE*
- *AVAILABLE AS OILTIGHT—FOR CAVITY MOUNTING*
- *EASY TO MOUNT*
- *EASIER TO WIRE*
- *INSTANT CHANGEOVER FROM MAINTAINED TO MOMENTARY CONTACTS*

A-B QUALITY

ALLEN-BRADLEY

MOTOR CONTROL

QUALITY

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada—Allen-Bradley Canada Ltd., Galt, Ont.

6-58-MR

A new "quality" standard for small REVERSING DRUM SWITCHES

A-B QUALITY

GOOD-LOOKING AND GOOD "FEELING" DIE CAST HANDLE

EASILY ACCESSIBLE MOUNTING HOLES

MERELY LOOSEN SCREW AND SLIDE PLATE to change from momentary to maintained contacts —or vice versa

INDEPENDENT SWITCH MOUNTING prevents misalignment

HEAVY CONTACT SURFACES for long operating life

TWO CONDUIT OPENINGS

WRAP-AROUND COVER gives complete access to drum

SINGLE SCREW COVER MOUNTING —screw cannot fall out

ACCESSIBLE SCREW TERMINALS for front wiring

RAISED EDGE for base mounting without spacers

maximum rating 2 horsepower

NEW OILTIGHT COVER PLATE FOR CAVITY MOUNTING

Bulletin 350 Reversing Switch can be furnished with oiltight cover plate with rubber gasket seal for cavity mounting in a machine base.

This *all-new* Allen-Bradley reversing drum switch was designed to keep pace with the mechanical beauty designed into so many of the modern machine tools.

The Bulletin 350 reversing switch is equivalent to a three-pole, double throw switch . . . and can be used with d-c motors; or single phase, two phase, or three phase a-c motors.

Investigate the Bulletin 350 . . . the *new leader* of its class . . . in appearance, ease of installation, and operating life. An Allen-Bradley *quality* switch . . . in every sense of the word. Send for descriptive bulletin.

ALLEN-BRADLEY

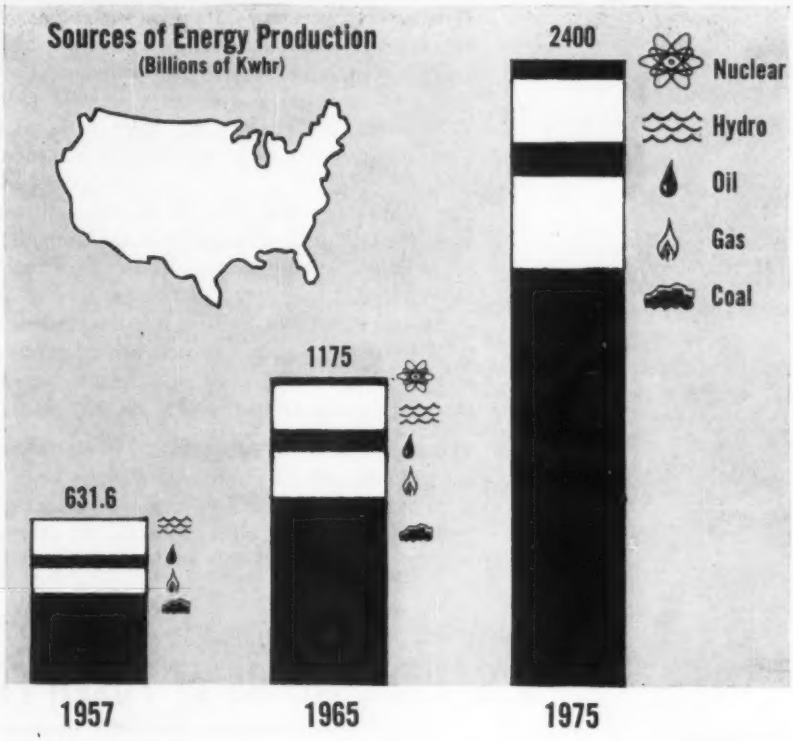
MOTOR CONTROL

QUALITY

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada—Allen-Bradley Canada Ltd., Galt, Ont.

6-58-MR

Report on
Fuel Outlook



King Coal to Reign through '75

Coal will dominate the utility fuel picture for the next 20 years. A recent study by Electrical World foretells a better than three-fold increase in the utilities' use of coal from now until 1975. During this period, King Coal will expand his lion's share of generation from 55% of the total to at least 66% by 1975. Coal transportation methods and the large capital requirements for coal production may be the top fuel problems of the future.

The study also showed that:

- **Nuclear power will be an insignificant part of the energy picture in 1975.**
- **Fossil fuel reserves for the period under consideration are adequate.**
- **Both oil and gas will get smaller shares of the utility fuel market.**
- **Hydro-electric power will also decline in importance as a source of energy.**

This study is designed to guide utilities in planning future fuel supply with respect to types of fuel, prices to be expected, and sources of supply. Two points of reference were chosen: 1965, for short range planning; and 1975, for planning new generating capacity. Considerations were availability, relative cost, capital requirements, competition with other forms of energy, and the political climate. This report will look at the national picture. Two subsequent reports will cover the findings region by region.

Total U. S. energy output in 1975 will be about 2.4 trillion kwhr, the study indicated. Coal will supply about 1.6 trillion kwhr, increasing its share of generation

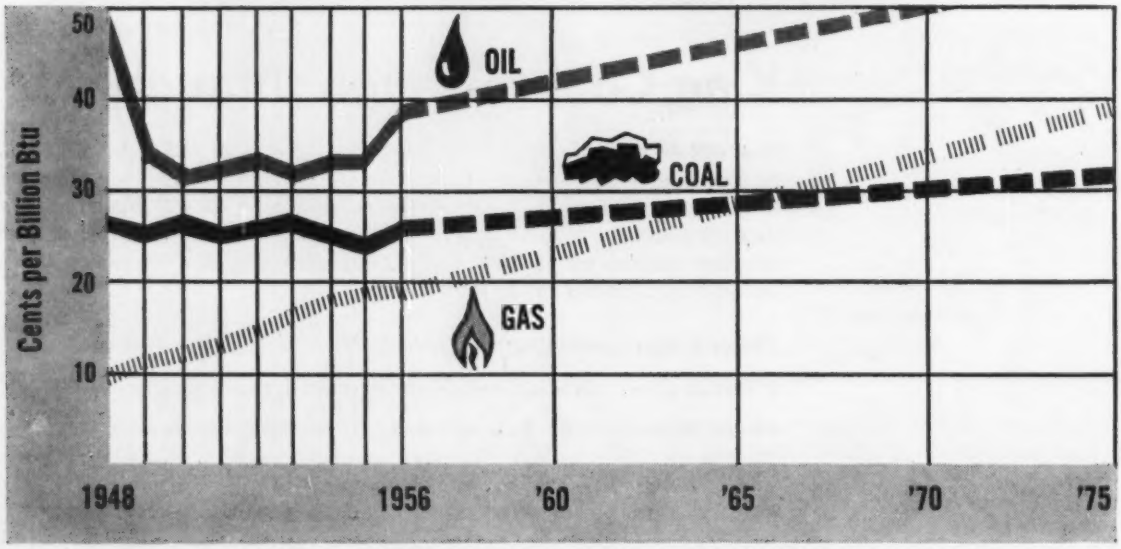
to about ⅔ of the total. With the exception of nuclear power, which has no way to go but up, all other fuels will provide a smaller share than they do today.

Hydro power will show the biggest percentage drop. Politics and rising construction costs may obstruct development of our remaining hydroelectric sites. Even assuming that in each region half the potential hydro capacity listed by the Federal Power Commission is developed by 1975, water power will then supply only 11% of the total generation. Only in the Mountain, Pacific, and West North Central regions will hydro still be an important source of power in 1975.

The utilities' use of oil will also decline. Although current crude oil reserves are more than adequate through 1975, the demand for higher-grade petroleum products will tend to keep residual oil out of utilities' boilers. In fact, economics have always argued against the use of oil as a boiler fuel. Today residual fuel oil represents no more than 15% of domestic refinery output, and this share has long been declining. Domestic heating oil and gasoline produce more profitable yields, and now residual oil itself is finding higher value use in the manufacture of petroleum coke, asphalt, and other materials.

The net result of this competition will be steadily rising residual oil prices. During 1958 oil, suffering from a momentary oversupply situation, may trend downward in price. For the long term, however, higher prices are in store—by 1975 probably about 40% higher than the '57 average. By that time oil will be significant as a boiler fuel only on the Pacific coast.

U.S. Price Trends of Fossil Fuels



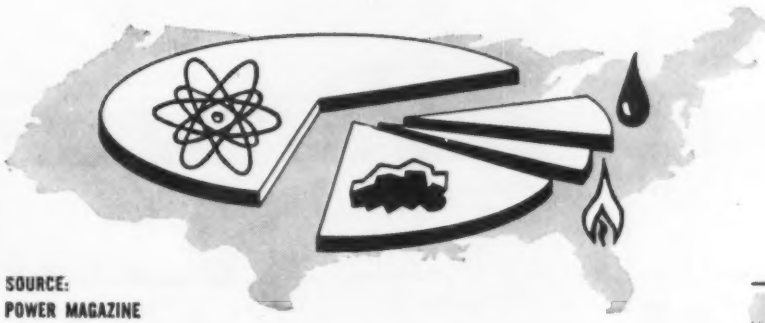
Gas presents much the same price, supply, and demand picture. The price trend for gas is up even more sharply than for oil. If this trend continues, which is likely, gas will cost the utilities twice as much in 1975 as it does today—becoming more expensive per Btu than coal sometime in the late 1960's. In spite of adequate reserves, this makes it unlikely that natural gas will continue its tremendous growth as a boiler fuel. Gas-fueled generation reached its peak in 1954, when it accounted for 25.7% of all U. S. electrical energy, but the percentage has already slipped off to 17.9%, and it will probably have dropped to about

12% by 1975. Today use of natural gas as a boiler fuel in regions outside the gas-production areas of the Southwest is almost entirely on a dump or off-peak basis. The gas industry is rapidly expanding its storage facilities, particularly in the Northeast, so that dump-gas will become scarcer. It will be more profitable to store it in the summer for winter use than to burn it under utility boilers.

At these higher prices, gas will all but disappear as a boiler fuel in some parts of the country. Only in the gas-producing West South Central region and the Pacific region will it retain much importance.

Coal has the most optimistic reserve picture of all the fossil fuels. The latest estimate puts U. S. coal reserves at 943 billion tons plus 525 billion tons of lignite. McGraw-Hill's "Coal Age" estimates that 152 billion tons of this (about 300 years' supply at current consumption) are mineable at present prices from deposits east of the Mississippi River alone. U. S. proven reserves of crude oil were 30.4 billion barrels as of Dec. 31, 1956. This indicates an 11.6-year supply assuming no additional discoveries, but we have been discovering oil faster than we produce it. Proven reserves of natural gas at the beginning of 1957 were 238 trillion cu ft (about 22 times annual production), but the American Gas Assn puts ultimate supply at more than three times the proven reserve.

U.S. Economic Fuel Reserves in Btu's



SOURCE:
POWER MAGAZINE

NUCLEAR ——→ 147×10^{17}

COAL (Incl. Peat) ——→ 62×10^{17}

OIL (Incl. Shale) ——→ 6×10^{17}

GAS ——→ 2×10^{17}

TOTAL ——→ 217×10^{17}

But fossil fuels are no longer the whole story. The chart above shows the energy equivalent of U. S. economic fuel reserves. Uranium accounts for twice as many Btu's as all the fossil fuels combined. McGraw-Hill's "Power" magazine puts our economic uranium reserves at 147×10^{17} Btu, and economic fossil fuel reserves at about 70×10^{17} Btu. Our ultimate energy reserves, says "Power", may include 280×10^{17} Btu from uranium and 510×10^{17} Btu from fossil fuels.

The much greater amounts of potential energy which would come from effective harnessing of thermonuclear and solar energy are not included. For the period under consideration, both can be dismissed quickly:

- **Thermonuclear electric power will not be in the picture by 1975.** Commercial fusion reactor plants are still anywhere from 20 to 50 years distant.

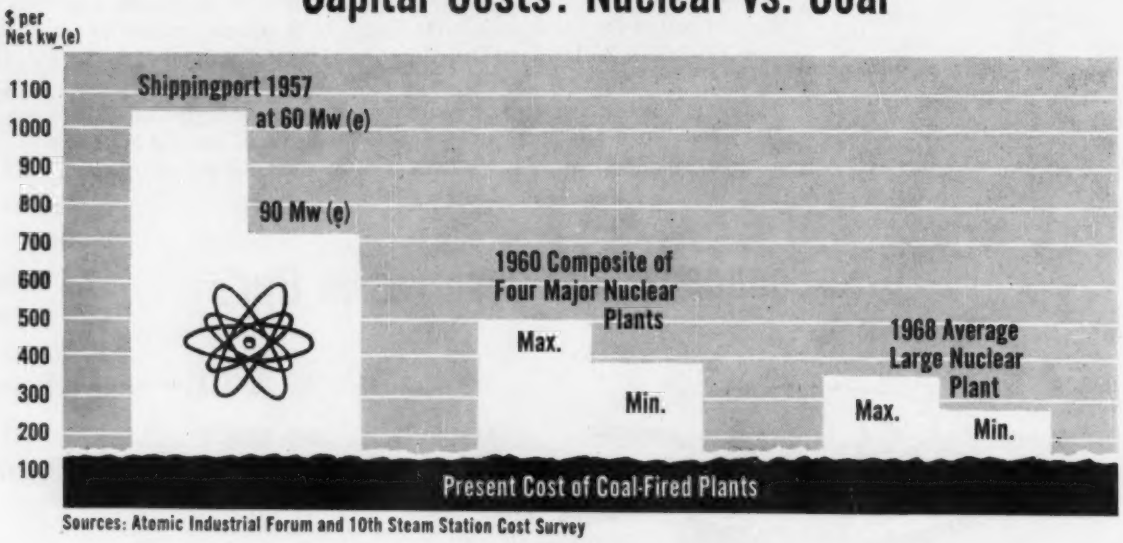
- **Solar energy seems to have a poor potentiality for power generation.** Although direct conversion into usable heat will surely compete to a limited degree, conversion to electrical energy takes too much space and is too expensive.

Nuclear power will not be a serious competitor by 1975, despite its unquestioned future importance. In 1975 it will probably contribute no more than 4% of

total generation. The reason for this is not dramatic. It is simply that conventional generation will still be cheaper in almost all parts of the U. S.

Data on nuclear power costs are meager and sometimes misleading. The only utility-size nuclear power plant now operating in the U. S., the 60-Mw Shippingport station unit, is estimated to have a power cost of 64 mills per kwhr—about nine times the cost of power produced at a new conventional plant. Reported fuel costs of this same station are about 16 times what they are for a new steam plant. Capital cost comparisons present much the same picture.

Capital Costs: Nuclear vs. Coal



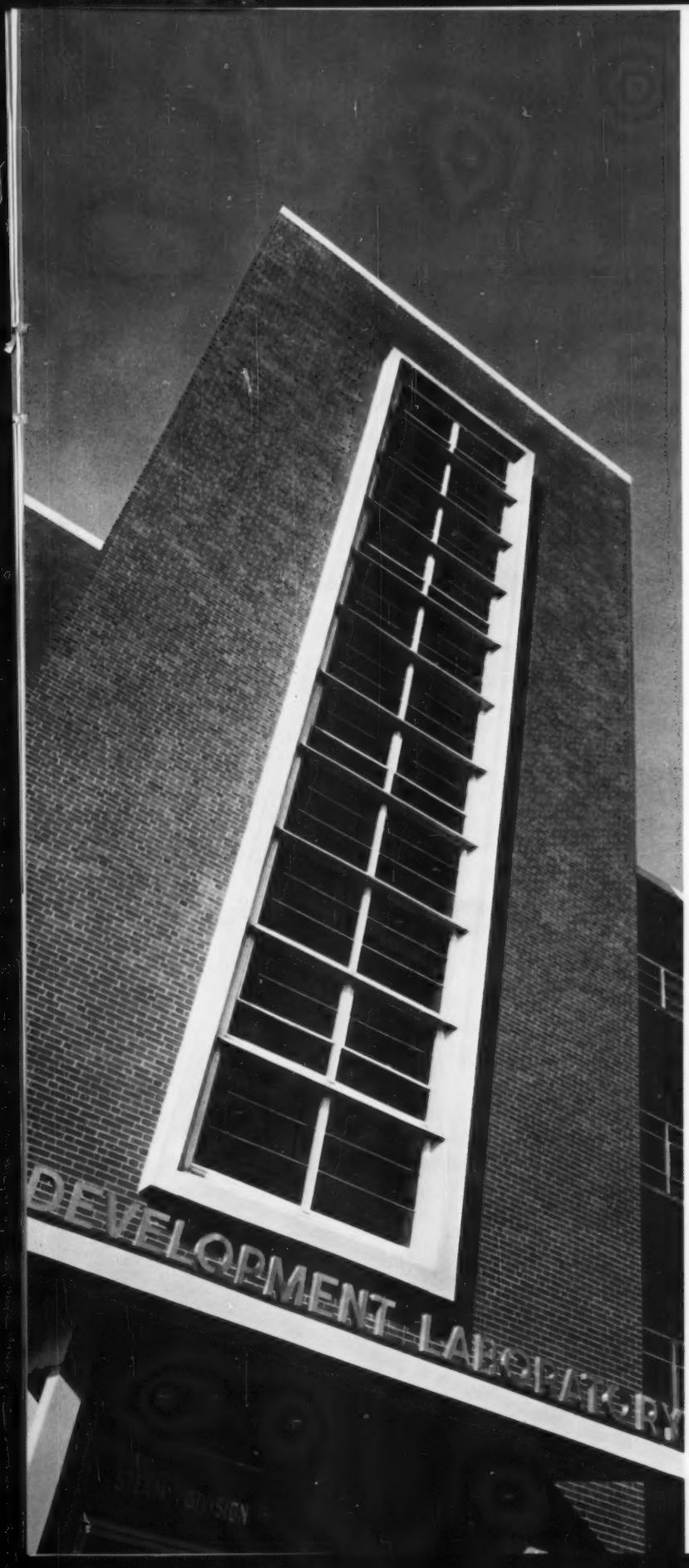
Sources: Atomic Industrial Forum and 10th Steam Station Cost Survey

Big reductions in these nuclear generation costs will be coming along soon, but not big enough to make nuclear power competitive in the period under consideration. The Atomic Industrial Forum has estimated capital costs of nuclear power plants as far ahead as 1968 (omitting any dollar-inflation effects), and has placed the minimum cost of a large plant in 1968 at $280 per net electrical kw. Although this is about one quarter of present Shippingport capital costs, it compares with a figure of $165 per kw for today's coal-fired steam plant. The inescapable conclusion is that only in extremely high fuel cost areas will nuclear generation play an important role for some time to come. Politics or foreign policy may foster more nuclear generation, but economics will not.

This leaves coal in the spotlight, at least through 1975. More than adequate reserves, the smallest price rises (in recent years its price has actually declined), and prospects for continuation of an excellent mine production record assure coal a position of dominance for at least the next 20 years.

Coal is not expected to continue downward in price. Inflation, if nothing else, will trend it up in the future. But its price ascent will not approach that of gas or oil. And this economy is sure to win for coal an even larger share of the utility market than it enjoys today.

The increased use of coal will bring problems with it. Next week's report will look at these problems and examine the utility fuel trend in four regions of the U. S. where coal is already the undisputed king of boiler fuels.



The credit goes to utility men

Of the many who share credit for today's low-cost electricity, one group deserves special mention. They are the utility men whose suggestions initiate many Westinghouse research and development projects . . . projects that result in new and more efficient designs for machines and equipment used by utilities.

Utility men have strong partners in the more than 6,000 scientists, engineers and technicians who work in the many Westinghouse research and development laboratories. For example, in this $6,000,000 Steam Development Laboratory, more than 100 engineers and technicians are developing new metals and more efficient designs for turbines and allied equipment.

Plowback of earnings into research at Westinghouse produces the *advanced* design machines that help utility men in their battle to generate more and more electricity, always at low cost.

YOU CAN BE **SURE**... IF IT'S

Westinghouse

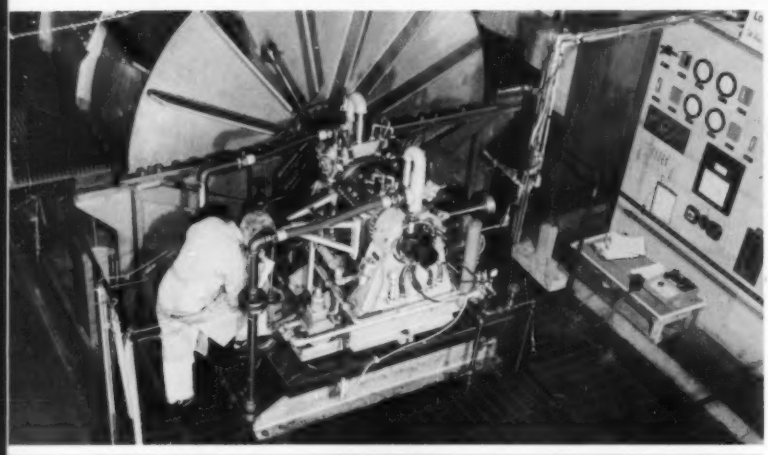
The 1970 turbine is here . . . in the Westinghouse laboratory!

ANOTHER EXAMPLE OF EARNINGS PLOWED BACK

It's here today because every day Westinghouse research and development engineers are getting the answers to the long-range questions, such as . . .

"Will the rotor alloy now used do the job under projected steam conditions?" If not, a research project is on its way to create the alloy that will be needed for the turbine of the future.

It takes longer to do the impossible, but Westinghouse starts doing it *before the need is an emergency*.



EFFICIENCY GAINS FOR L-P TURBINES

In the Steam Development Laboratory, a major development project is aimed at significant gains in the low-pressure end of the turbine. The project revolves around a unique L-P turbine test facility. Using this $1,000,000 development tool, Westinghouse engineers are testing numerous combinations of new designs, recording the performance of every part under varying conditions.

NEW BLADING ALLOY

What's to be used when advanced steam conditions exceed the limits of blading metals now available? Development engineers are now evaluating a new Westinghouse alloy that may be the metal of the future. *For example, at 1200°F,* the tensile strength is phenomenal—100,000 psi; the damping characteristics—excellent. After exhaustive tests are completed, Nivco alloy will be introduced as another Westinghouse "first."

WORLD'S MOST EFFICIENT TURBINE

A new peak of efficiency for that 1970 turbine will be assured by hard-won development steps taken within the next 12 years. A giant step is the turbine-generator now under construction for the Philadelphia Electric Company. *It will be the world's most efficient turbine.* This 325,000-kw super-critical unit will use the highest temperature and pressure steam ever projected . . . 5,000 psi at 1200°F.

JI-97233-2

YOU CAN BE SURE...IF IT'S Westinghouse

Oxley Assumes New Responsibilities at DP&L

Kenneth G. Oxley, vice president and manager of electric operations for Dayton Power & Light Co, has been named associate general manager of the utility.

Oxley, who has held his most recent position since 1957, has been associated with DP&L in various capacities since 1940. Prior to that he was with the Iowa Electric Light & Power Co, Natural Gas Pipe Line Co of America, and United Light & Power Service Co. He is a graduate of Iowa State College in electrical engineering.

Oxley has been active in Community Chest work, serving as co-chairman of Public Services Division in 1957 and is associate general chairman of Public Services and Construction Divisions this year.

In other promotions, Philip K. Pfanner was named an assistant vice president; Robert F. Isenhart was made manager of the company's Services Division; and David R. Jaques became manager of the Employee's Education and Information Division.

K. G. OXLEY

Westinghouse Elects Three Vice Presidents

SIMPSON JONES SARGENT

Three newly elected vice presidents of Westinghouse Electric Corp are John W. Simpson, Thomas P. Jones, and Richard J. Sargent.

Simpson is former manager of the Bettis Atomic Power Division. A 20-year Westinghouse veteran, he has specialized in nuclear work for the past 12 years. He once was manager of the Shippingport project.

Jones, previously manager of the Atlantic region apparatus products sales office, has held various sales posts in that region for 28 years.

Sargent has been manager of marketing and distribution for Consumers Products Divisions in recent years.

Anaconda, American Brass Name Top Officers

In recent top executive promotions, Anaconda Co elected Clyde E. Weed chairman of the board and chief executive officer of the parent and three subsidiaries, Chile Copper Co, Chile Exploration Co, and Andes Copper Mining Co. His post as president of these organizations is now assumed by Charles M. Brinckerhoff. In addition, C. Jay Parkinson has been advanced from general counsel of Anaconda to vice president.

WEED BRINCKERHOFF COE STEWART

American Brass Co, a wholly-owned Anaconda subsidiary, has elected John A. Coe and Richard M. Stewart to new positions. Coe becomes chairman of the board and continues as chief executive officer. Stewart, former director of Anaconda's industrial relations, was elected president of American Brass.

CLOSE FLETCHER KEEFER ALTHAUSER

Four VP's Elected at Alcoa

Aluminum Co of America has elected four new vice presidents: F. J. Close, B. J. Fletcher, R. O. Keefer, and N. R. Althauser.

Close, a 29-year Alcoa employee, has been general manager of the sales development and commercial research divisions for the past two months.

Fletcher has held various engineering positions during his 32 years at Alcoa and has been general manager of engineering since February.

Keefer and Althauser have been general purchasing agent and controller, respectively, for the company.

I-T-E Ups Schmidt to VP

Ernie A. Schmidt has been elevated from midwest regional sales manager to commercial vice president of I-T-E Circuit Breaker Co.

As vice president, Schmidt will maintain sales jurisdiction over all sales activities in Illinois, Ohio, Michigan, Indiana, Wisconsin, Missouri, Minnesota, Iowa, Nebraska, Oklahoma, Kentucky, Kansas, North Dakota, and South Dakota. He will also contribute toward establishment of company sales policy. Schmidt will retain his offices at Bankers Building, Chicago.

PERSONAL BRIEFS

John A. Reed's promotion as general sales manager of Southwestern Gas & Electric Co coincides with a stepped-up program of industrial development and sales promotion by the utility. **John B. Struwe** was made manager of the industrial development dept. SG&E's new assistant controller is **J. Lamar Stall.**

Alabama Power Co has named **Judson F. Webb, Jr,** as Birmingham Division's superintendent of distribution; **W. O. Whitt** as superintendent, Birmingham district; and **Carlton T. Teague** as Bessemer district superintendent.

Clement P. Corey succeeds retiring **W. S. Cavanaugh** as superintendent of New England Electric System. His post as chief load dispatcher at Millbury, Mass., has been assigned to **Donald P. Reed.**

Central Maine Power Co has appointed **Paul L. Johnson** to succeed **John A. Perry** as chief load dispatcher . . . **Anthony G. Maihofer** is new secretary of Detroit Edison Co.

At Montana Power Co, **Emmett F. Buckley** has been promoted to manager, tax and insurance dept. He succeeds **Robert E. Crangle,** who is retiring.

General Electric Co's outdoor lighting dept has named **K. D. Tobin** as manager of product planning, product service, and market research . . . **John P. Rubie** is new manager-materials of magnetic materials section . . . The new post of manager of nuclear applications in Europe for GE's atomic power equipment dept has been assumed by **Bruce R. Prentice** . . . The Legal Services Division has appointed **Everett L. Hollis** corporate counsel; **Laurence I. Wood,** labor and government relations counsel; and **Merrill Brown** contract and claims counsel.

Joel S. Tompkins is new chief power engineer for Aluminum Co of America . . . Kaiser Aluminum & Chemical Corp has named **Alexander N. Shealy** head of the electrical engineering branch, dept of metallurgical research.

At Babcock & Wilcox Co, **Joseph C. Delibert** has been made an administrative assistant to **M. Nielsen,** president, and **Raymond J. Cantwell** was elected comptroller . . . **Theodore M. Dillaway** is new secretary of Buffalo Forge Co.

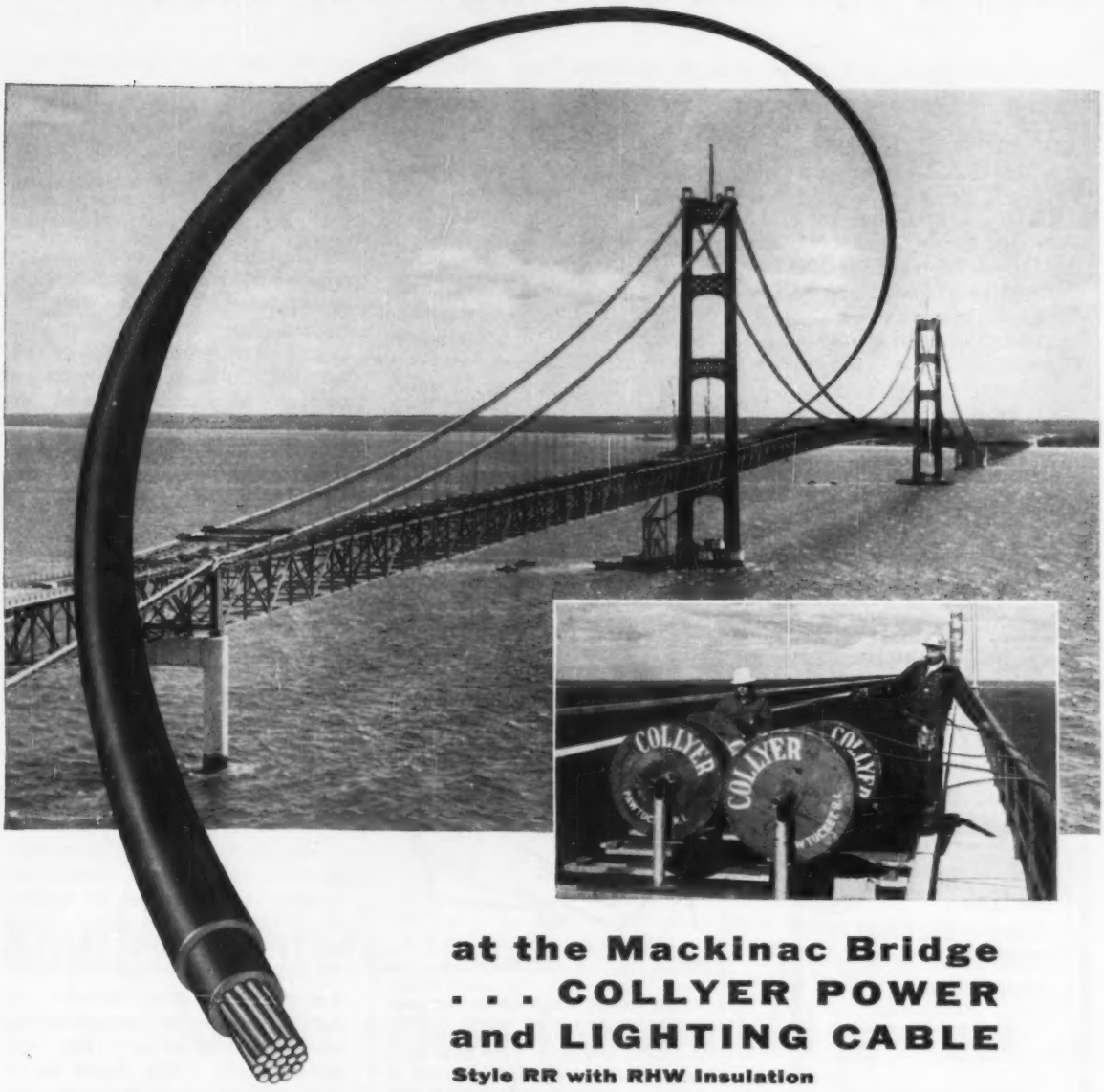
Raytheon Manufacturing Co recently appointed **John T. Thompson** manager of its new Distributor Products Division . . . **Elliot F. Jaquith** is chief engineer of Stone & Webster Engineering Corp's new Industrial Projects Division.

Atomics International, a division of North American Aviation, Inc, has given **Clement F. Burnap** of the technical sales dept responsibility for licensing activities in connection with marketing nuclear reactors abroad.

New president of S&C Electric Canada, Ltd, is **A. R. Morrison,** former vice president-general manager.

Frederick W. Walker, Jr, has been elevated to assistant general sales manager in charge of electric utility sales for General Motors' Electro-Motive Division. He is succeeded as Chicago regional manager by **James B. Swindell.**

Another call for Collyer . . .



at the Mackinac Bridge . . . COLLYER POWER and LIGHTING CABLE

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THE WORLD'S LONGEST SUSPENSION BRIDGE, the State of Michigan's new $100,000,000 Mackinac Bridge, is wired with thousands of feet of Collyer lighting and power cable — Style RR with RHW insulation.

THIS ENGINEERING TRIUMPH is a credit to the vision of the people of Michigan, the Mackinac Bridge Authority, and their Consulting Engineer, D. B. Steinman of New York. Collyer is proud that their Style RR lighting and power cable with RHW insulation is a part of this vital link in American progress.

FOR QUALITY CONSTRUCTION and maximum serviceability on all types of municipal and private installations, more and more engineers everywhere "call on Collyer" for cable. Let us quote on your specific requirements. Write **Collyer Insulated Wire Co., 247 Roosevelt Ave., Pawtucket, Rhode Island.**

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PEA Discusses Serving Heat Load

T&D Committee at Pocono Manor hears higher utilization voltage is economic answer to serving all-electric home

A higher utilization voltage could become the economical answer to problems arising from growth of the all-electric home. This E. M. Adkins, Jersey Central Power & Light Co, told the Transmission & Distribution Committee of Pennsylvania Electric Association at the May 1-2 meeting at Pocono Manor, Pa. R. F. Lawrence, Westinghouse Electric Corp, discussed the distribution system for the all-electric home.

Adkins said that popularization of the all-electric home with its high demand and energy use will further shorten the economic lengths of secondary circuits and approach the load limit of overhead supply at present voltages. A higher utilization voltage, such as 240/480 v, would double allowable secondary circuit length, based on voltage regulation, but would be uneconomical unless a low-cost transformer becomes available to step down to 120/240 v for service to existing customers.

Using comparative cost data, Adkins showed that both residential air conditioning and house heating are very desirable loads. But, with all other things the same, a saturation of about 13% of all-electric customers would double the average kwhr usage for residential consumers over 1957 values without any other increases in energy usage. Thus, Adkins concluded, present distribution supply facilities would be seriously strained under only moderate saturation of air conditioning or electric heating.

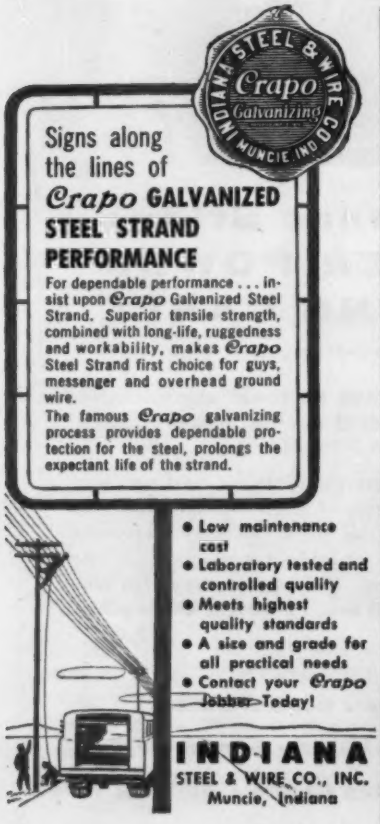
Formerly, secondary mains were warranted by the saving in transformer capacity realized by using a larger transformer to supply a greater number of consumers through secondary mains for a common secondary supply bus. This scheme proved lower in annual cost than the use of smaller transformers on each service take-off pole without any secondary main. In recent years, however, the cost of new conductor capacity has increased at a somewhat faster rate than has transformer cost. Consequently, Adkins noted, the choice between a secondary main or none is sometimes a narrow one. Lawrence said that a higher primary voltage is economical at the higher load densities.

The economy of a higher primary voltage depends almost entirely on the ability to eliminate a substation transformation step, Lawrence said. For this reason, the economical use of primary voltages above 15 kv depends on the available subtransmission voltage. Practical use depends on economic availability of distribution transformers, surge protection, and circuit sectionalizers.

Reliability Needed

The all-electric home, Lawrence declared, will require greater reliability than provided by today's distribution standards and construction. Use of extensive low-voltage circuits on the higher secondary voltage system would improve reliability over present systems having more extensive primary runs. Secondary aerial cables would be an improvement over open-wire, and primary cables would also improve reliability but they present problems, such as tapping hot lines.

Lawrence said that higher secondary voltages and underground distribution go hand in hand. The latter will go a long way toward improving reliability to an acceptable degree for all-electric living. He cited studies of a direct buried system to show that the distribution plant investment of 34.5 kv to a higher secondary voltage would be less than for 34.5 kv to 4 kv to 120/240-v conventional overhead at 3½ kva or more diversified demand.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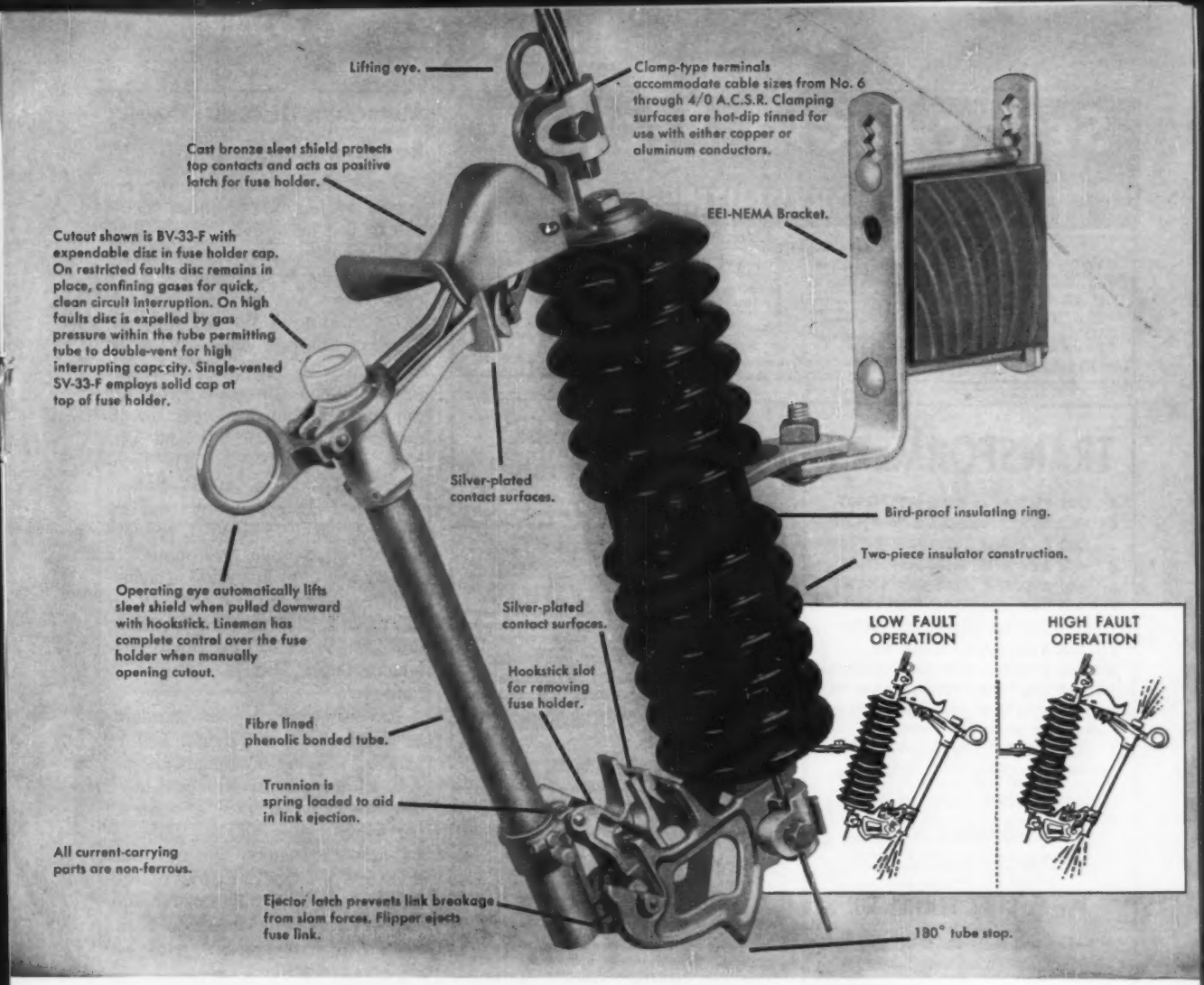
Lifting eye.
Clamp-type terminals accommodate cable sizes from No. 6 through 4/0 A.C.S.R. Clamping surfaces are hot-dip tinned for use with either copper or aluminum conductors.
Cast bronze sleet shield protects top contacts and acts as positive latch for fuse holder.
EEI-NEMA Bracket.
Cutout shown is BV-33-F with expendable disc in fuse holder cap. On restricted faults disc remains in place, confining gases for quick, clean circuit interruption. On high faults disc is expelled by gas pressure within the tube permitting tube to double-vent for high interrupting capacity. Single-vented SV-33-F employs solid cap at top of fuse holder.
Silver-plated contact surfaces.
Bird-proof insulating ring.
Two-piece insulator construction.
Operating eye automatically lifts sleet shield when pulled downward with hookstick. Lineman has complete control over the fuse holder when manually opening cutout.
Silver-plated contact surfaces.
Hookstick slot for removing fuse holder.
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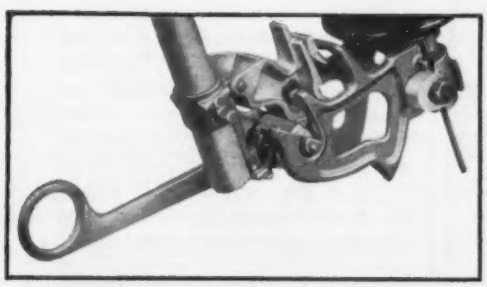
All current-carrying parts are non-ferrous.
Ejector latch prevents link breakage from slam forces. Flipper ejects fuse link.
180° tube stop.
LOW FAULT OPERATION
HIGH FAULT OPERATION

Southern States new cutout offers double action for double protection



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An expendable disc in the fuse holder cap does the trick! On low faults it remains intact, restricting gases within the tube for maximum arc-quenching ability. On high faults the disc blows out, permitting the cutout to double-vent for maximum interrupting capacity.

Compare the features of the BV-33-F with any other cutout. Add to them the double protection it offers, and you have the answer to your cutout requirements.

For complete details, see your local Southern States representative, or write direct for Bulletin 570-C.

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3— 500 KVA G-E 22000-2300/4000Y
3— 500 KVA W-H 13200-2300/4000Y
3— 333 KVA Mol 33000-7200/12470Y
3— 333 KVA W-H 13800-240/480
3— 333 KVA Mol 2300/4000Y-230x460
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3	1000	G.E.	66,000–33,000
3	1000	G.E.	66,000–2300/4000
3	667	Kuhl.	66,000–480
1	2000	West.	44,000–2400, 3 Ph.
3	200	West.	44,000–480
1	5000	West.	34,500–13750/6875, 3 Ph.
1	3750	G.E.	34,400–13800/7960, 3 Ph.
2	3000	Stand.	33,000–4160, 3 Ph.
1	1500	Mol.	34,500–460, 3 Ph.
2	1500	G.E.	34,400–2520, 3 Ph.
3	1000	A.C.	34,650/11,500–2300
3	200	A.C.	34,500–2400/7200/12470Y
1	3000	A.C.	23,380–2500/4330Y, 3 Ph.
3	2000	A.C.	26,400/13,200–2390/4140
3	1250	G.E.	26,400/13,200–2400/4150
2	1500	G.E.	23,000–2400/4800, 3 ph.
3	100	G.E.	22,000–7200/12470Y
3	50	G.E.	22,000–2300
3	2500	G.E.	13,800–2300, 3 Ph.
3	1667	G.E.	13,800–600
1	1000	G.E.	13,800–600, 3 Ph. Unit Sub.
3	667	Kuhl.	13,800–480
1	600	Stand.	13,200–2300, 3 Ph.
1	450	Penna.	13,200–2400, 3 Ph. Askarel
1	4500	West.	7200–2400, 3 Ph.
3	125	A.C.	6900–2300
3	100	G.E.	4800–120/240
3	150	West.	2400–230/115
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1	500	G.E.	694 A. 4160 V. 3 Ph. STEP
1	250	A.C.	601 A. 2400 V. 3 Ph. STEP
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Metermen Discuss Random Sampling

Random-sample testing of residential single-phase watthour meters will be put into effect by two electric companies, the Meter Committee of the Pennsylvania Electric Association was told at its April 24-25 meeting at Wernersville, Pa. Consequent upon approval of the West Virginia regulatory commission, Potomac Edison Co will adopt random sampling this year for its meters in West Virginia and Virginia, said A. J. Keen. The company will take a 10% random sample of meters due for testing this year, or 1.25% of all residential meters. Samples will be divided into three groups by period of manufacture—1925 and older; 1926-1940; and 1940 to present. Keen said that Class 200 extended-range meters might also be sampled at random.

Present group accuracy standards in effect in West Virginia will be adhered to in testing meters chosen. Any of the groups will be judged satisfactory when 95% or more of the sample have 98 to 102% of full-load registration and not more than 5% are above 102% of full-load registration. With this random-sample technique, Potomac hopes to save 50% of present meter testing cost, said Keen.

Ohio Power Co's random-sample procedure, said R. V. Kelch, residential single-phase watthour meters will be analyzed on the basis of age (five classes), make (four classes), and location (two classes), for a total of 40 different categories.

If 2% of the sample of any class is not more than 2% out, the class will be satisfactory. If 2% of the sample is more than 2% out, this class will be replaced or continue on an eight-year test cycle. If the class is retained in service random samples will be taken every year. If 2% of the sample comes within 2% in a subsequent year, then only random samples will be tested thereafter.

The tests will be at full-load registration. The new handling system is mechanized from the time meters which are removed from shipping cartons until repacked in the same cartons for transportation to the field.

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The Meetings Calendar

JUNE

• **American Gear Manufacturers Association**—42nd Annual Meeting, The Homestead, Hot Springs, Va., June 1-4.

National Telemetering Conference—Lord Baltimore Hotel, Baltimore, Md., June 2-4.

National District Heating Association—49th Annual Meeting, French Lick-Sheraton Hotel, French Lick, Ind., June 2-5.

Northwest Electric Light & Power Association—Accounting & Business Practices Section, Olympic Hotel, Seattle, Wash., June 4-6.

Conference Internationale des Grands Reseaux Electriques—17th Convention on Large Electric Systems, Paris, France, June 4-14.

Electrical World—Third Electric Space Heating and Heat Pump Conference, Barbizon-Plaza Hotel, New York City, June 5-6.

Public Utilities Association of the Virginias—Accident Prevention Conference, Hotel Roanoke, Roanoke, Va., June 6.

Electric Companies Public Information Program—Inter-Regional and Steering Committees, Boston, Mass., June 8.

National Association of Electric Distributors—Annual National Convention, Civic Auditorium, San Francisco, California, June 8-12.

Edison Electric Institute—26th Annual Convention, Boston, Mass., June 9-11.

Fourth International Automation Exposition and Congress—New York Coliseum, New York City, June 9-13.

The American Society of Mechanical Engineers—Semi-Annual Meeting, Statler Hotel, Detroit, Michigan, June 15-19.

Michigan Electric Association—Annual Convention, Grand Hotel, Mackinac Island, Mich., June 22-25.

American Institute of Electrical Engineers—Summer General Meeting, Buffalo, N. Y., June 22-27.

The American Society of Testing Materials—Annual Meeting, Statler Hotel, Boston, Mass., June 22-27.

JULY

National Housewares and Home Appliance Manufacturers Exhibits—Auditorium, Atlantic City, N. J., July 7-11.

Colorado Farm Power Council—Electric House Heating School, co-sponsored by Colorado State University Agricultural Engineering Department, Colorado State University, Fort Collins, Colo., July 10-11.

Western Summer Radio-Television & Appliance Market—Western Merchandise Mart, San Francisco, Calif., July 21-25.

AUGUST

• **Southeastern Electric Exchange Public Utility Executive Course**—Georgia Institute of Technology, Atlanta, Ga., Aug. 4-29.

• **American Institute of Electrical Engineers**—Special Technical Conference on Non-Linear Magnetics and Magnetic Amplifiers, Hotel Statler, Los Angeles, Aug. 6-8; Pacific General Meeting, Sacramento, Calif., Aug. 19-22.

• **The Institute of Radio Engineers**—Conference on Electronic Standards and Measurements, NBS Boulder Laboratories, Boulder, Colo., Aug. 13-15.

• **Illuminating Engineering Society**—National Technical Conference, Royal York Hotel, Toronto, Canada, Aug. 17-22.

• Additions this week.

MORE BIG DATES FOR '58

Rocky Mountain Electrical League—Annual Fall Convention, Jackson Lake Lodge, Moran, Wyo., Sept. 14-17.

National Electrical Manufacturers Association—Annual Meeting, Atlantic City, Nov. 10-14.

National Association of Railroad and Utilities Commissioners — Annual Convention, Westward Ho Hotel, Phoenix, Ariz., Nov. 17-20.

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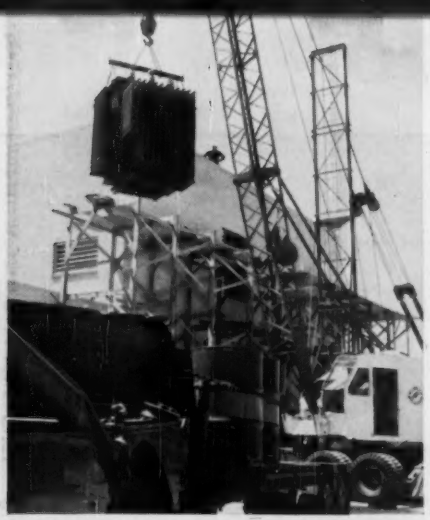
SILVIUM GRIDS IN EXIDE-MANCHEX BATTERIES

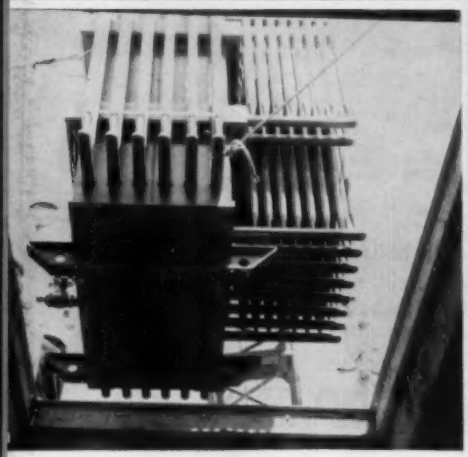
for longer life

No battery in the world matches Exide-Manchex for long life. Now, with Silvium* alloy grids in the positive plates, life potential is even greater. Yet you pay no more. This is more reason than ever to insist on Exide-Manchex for your stationary battery applications.

*Silvium is an Exide patented grid alloy proved as much as 100% more corrosion resistant than others.

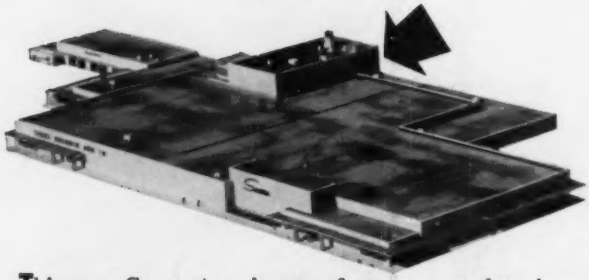
Exide®





POWER ON THE ROOF INCREASES EFFICIENCY...

at Sears' new Amarillo shopping center



This new Sears store is one of many new shopping centers springing up in growing Amarillo, Texas. Following the modern trend, all floor space has been devoted to merchandise and display. Air-conditioning and operating equipment is installed on the roof—out of the way.

To put power where it was needed—on the roof to eliminate the losses and expense of long secondary copper runs—Southwestern Public Service Company selected Kuhlman. A regular user of Kuhlman, Southwestern knew from past experience that Kuhlman transformers would provide the required reliability. Then, too, like all Kuhlman customers, wherever they are located, Southwestern benefits from the close, friendly service of a nearby Kuhlman factory.

Whether it's distribution or power, for industrial, commercial, or residential use, you'll find Kuhlman transformers are designed to meet standard specifications as well as special conditions. Talk over your requirements with your Kuhlman representative. He lives in your area and knows your needs.

KUHLMAN POWER TRANSFORMERS

KUHLMAN ELECTRIC COMPANY General Offices: Birmingham, Michigan

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